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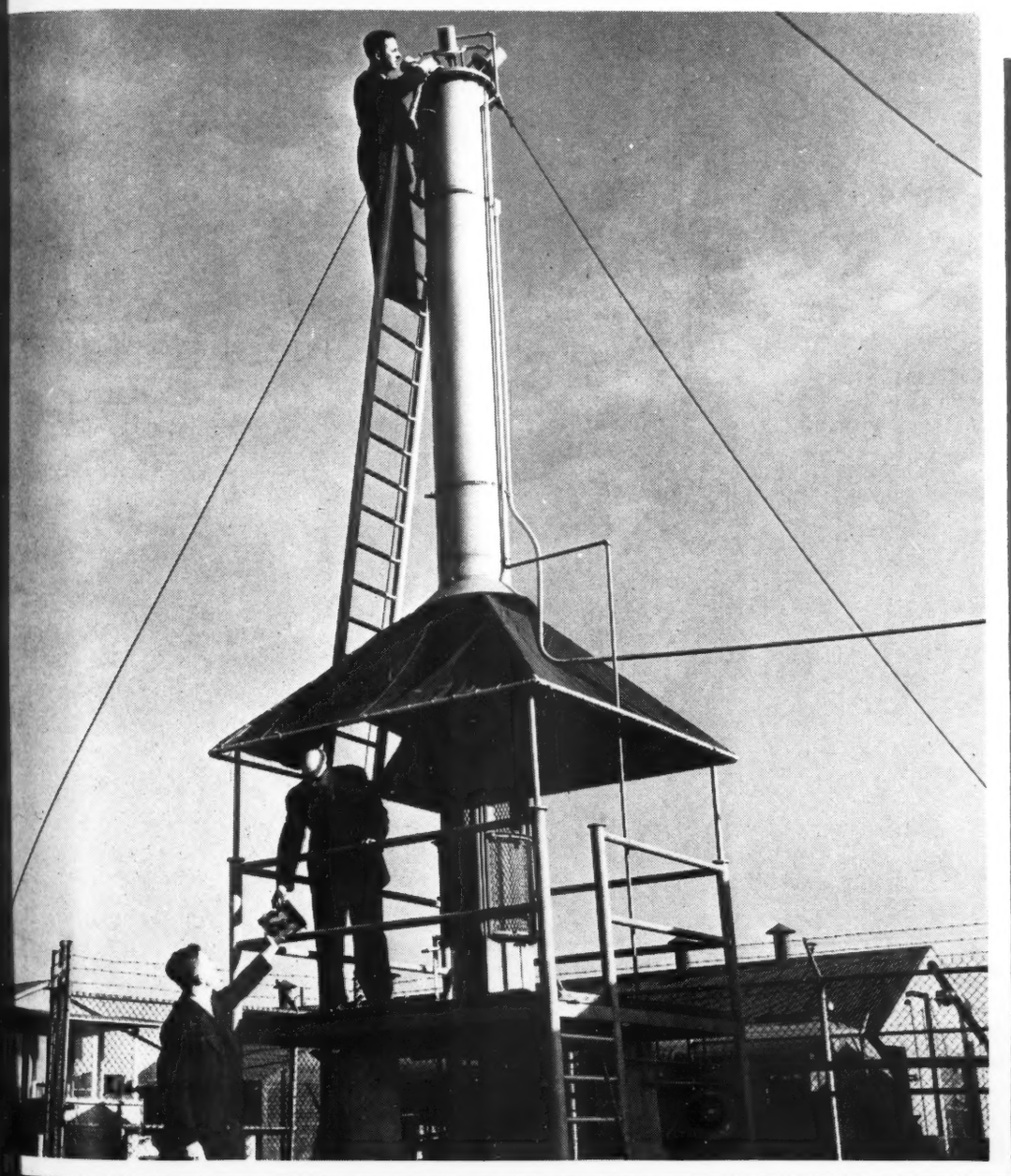

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27-foot pneumatic mortar subjects equipment to heavy gravity loads

VOLUME 52 • NUMBER 11 NEW YORK • LONDON

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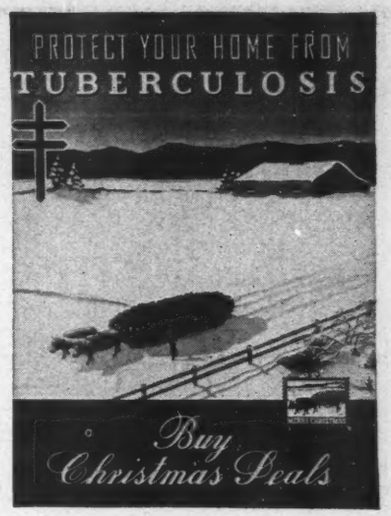

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ON THE COVER

TO determine what happens to electronic and mechanical devices for airplane control when they are subjected to rapid acceleration in flight, the Boeing Aircraft Company developed a huge gun that fires them through a tube at speeds up to 50 miles per hour and stops them gradually by means of an air cushion. The apparatus permits testing such equipment without making expensive and perhaps dangerous flights. Another picture and a more complete description of the gun appear on page 279.

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IN THIS ISSUE

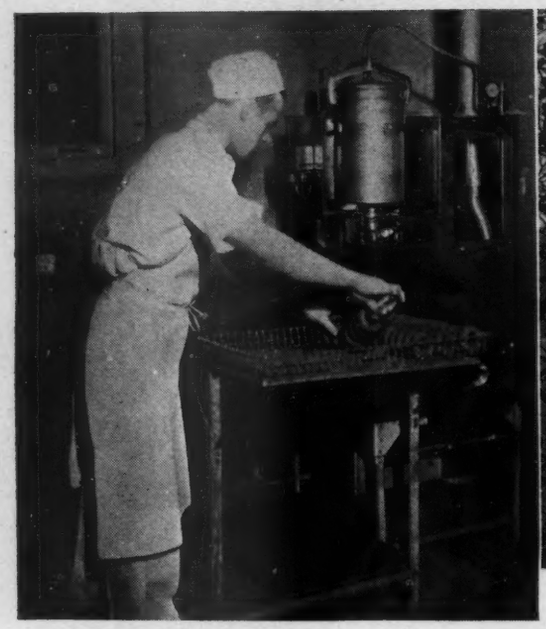
COFFEE and "sinkers" is somewhat of a national institution, especially to those toilers who rise late and take breakfast on the run. The term "sinker" connotes heaviness and the Doughnut Corporation of America is doing all it can to efface the memory of the leaden, soggy doughnuts of yore. As told in our leading article, that concern turns out ingenious machinery and accurately proportioned flour mixtures to produce a tasty and wholesome food for millions of Americans.

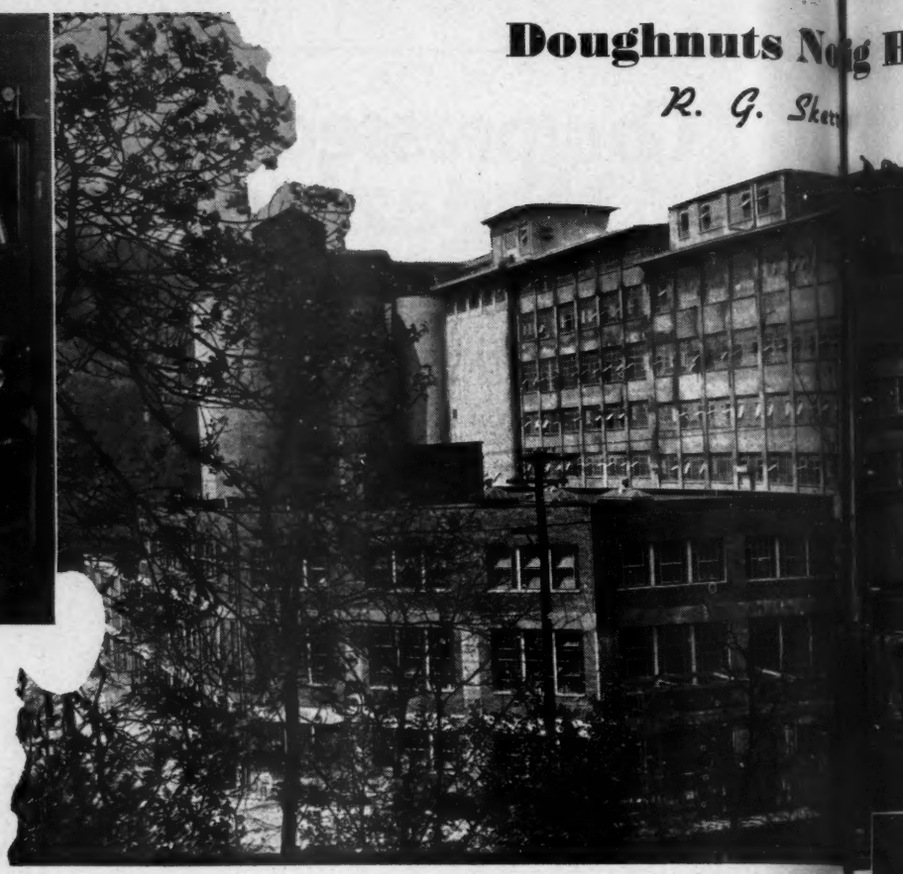
•

THE story of wartime tunneling operations that were carried on in Syria by South African gold miners is presented on page 268. How a Canadian City uses air-powered equipment to save time and money in connecting new water consumers to street mains is described on page 272. *Mining at a Snail's Pace* (page 274) tells of a mine that pays off although it produces no ore. *Old Pumping Engine Preserved for Posterity* (page 276) describes an interesting relic of early iron mining in Michigan.

Doughnuts No[illegible] H

R. G. Sket[illegible]





The optimist, the pessimist,
The difference is droll:
The optimist the doughnut sees,
The pessimist—the hole.

ADOLPH LEVITT was the optimist, and he did, indeed, keep his eye on the doughnut. Some people classed him as just one more visionary; but, nonetheless, he pioneered and gave impetus to a national business that has grown in value from $21,000,000 twenty five years ago to $175,000,000 today. The Doughnut Corporation of America still retains its leadership in this field of our diversified bakery industry.

In the truly "Down-East" section of New England the doughnut has been a product of the kitchen ever since the days of the pioneer settlers. In its making, it has ranged from a perfunctory to a prideful accomplishment and has varied widely in its appeal to the palate. Even so, it persisted in New England largely because custom had established it there among a traditionally conservative people. In that region, doughnuts were fried in an open kettle filled with boiling fat, and the dough was commonly compounded from such flour and other ingredients as happened to be at hand on the day appointed for their making. Those cakes lacked uniformity in get-up and taste, and their freshness was frequently fleeting. One could tell closely how old they were by their steadily increasing staleness, a characteristic that may have been the inspiration, if not the need, for dunking them in the morning cup of coffee. Thus was born a hankering for doughnuts that could be had fresh daily—something that was not just a poor relative of good cake, but its equal.

In the past, the average baker, even in New England, looked upon the doughnut as the least desirable of his commodities, and the nation generally was not familiar with that foodstuff. It took World War I and the Salvation Army lassies to make that friedcake known, and it is a matter of record that the doughnuts which they cooked in the battle areas on extemporized facilities and served with coffee worked wonders on the wearied and nerve-wracked fighting men. Gauged by present-day standards they probably were far from "tops"; but, nevertheless, they were a boon. Thousands in our armed forces then ate their first doughnut, and the taste lingered after they returned to their homes in widely distributed sections of the country. It was at that time that Adolph Levitt came into the picture.

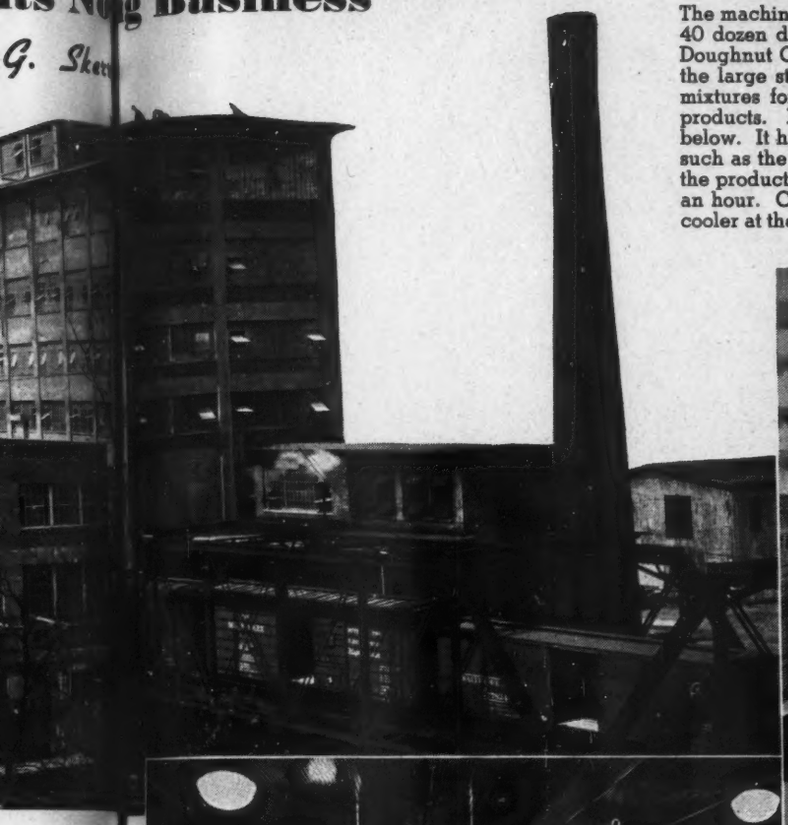
In 1919 he was operating a small chain of retail bakeries in New York City, and to make his breads, cakes, and pastries of broader appeal he prepared them by then-novel mechanical aids and in full sight of passers-by. One of his shops was on Fulton Street, in the heart of the business section of downtown Manhattan, and attracted people by reason of the sanitary way in which the wares were turned out. Returning servicemen were among the customers, and Adolph Levitt promptly recalled what the doughnut, fresh and hot, had meant to them in Europe. "Why not," he asked himself, "set up a kettle in the front of the shop and fry doughnuts?"

That's what he did, and the venture was an immediate success. But that essay had a setback: the fumes of the boiling fat—none too pleasing to many persons—permeated the neighborhood and finally aroused his landlord, with the result that he either had to abandon his doughnut-making or move. He hated to drop that business, for he had learned that the public was keen for his doughnuts; and the new line promised substantial returns. It was then that the idea occurred to him to devise a machine that would cut doughnuts, fry them, and whiff away any objectionable odors to the nearest chimney top. Machinery to lighten labor and expedite operations in the bakery was already winning favor, and the problem, in principle, seemed simple to that optimist.

At that time a qualified baker could cut and fry daily something like 250 dozen doughnuts of widely varying size and quality. Mr. Levitt expected his apparatus to do better work and to do it three times faster than its human competitor. Along in 1921, the Display Doughnut Machine Corporation came into being, and the first "successful doughnut-making machine" was announced. Prior to that, Mr. Levitt had found someone with a kindred faith in his project, a Mr. Yaeger, an engineer. He was commissioned to build the first unit, and did so after months of effort and repeated failures. It was designed to turn out 80 dozen doughnuts an hour,

DOUGHNUT MACHINES AND PREMIX FLOUR MILL

The machine at the extreme left, designed to serve small bakeries, can produce 40 dozen doughnuts an hour. In the center is shown the main plant of the Doughnut Corporation of America at Ellicott City, Md. Flour that is milled in the large structure is combined with other essential ingredients to form premixtures for making doughnuts, as well as various other bakery and home products. For medium-size bakeshops, the concern makes the unit pictured below. It has a capacity of 40 dozen friedcakes hourly. The larger machines, such as the one pictured at the bottom, are really small factories operating on the production-line principle. They turn out from 200 to 600 dozen doughnuts an hour. Coming from a frying unit in the rear, they travel by belt through a cooler at the right, thence to a coating unit at the left, and finally to the packers.



a great quantity judged by manual production and also a staggering number to be sold, day in and day out!

Despite the machine's sanitary operation and the superiority claimed for the finished product, the idea lacked appeal to investors, and the corporation could hope for business only if it could induce the bakery industry to use the equipment. But bakeries did not subscribe to the belief that such large quantities of doughnuts, no matter how good, could assuredly be marketed. As other revolutionaries had done before, the concern got out a booklet with pictures and persuasive text. But before that brochure was off the press, the inventor made an attempt to feel out the industry, and what happened has been described as follows:

"Mr. Levitt had selected five prospects—the likeliest in the industry, he felt—and approached them with a view to selling them the new mechanical marvel. Two of his prospective customers thought the idea of a doughnut machine preposterous. They shooed Mr. Levitt out of their offices without even bothering to glance at the photos and reports of tremendously successful operation of the machine in the Levitt bakery chain. The three other businessmen were more polite—but very disinterested in the idea."

Sales resistance is an old story. So, following out the idea tried in his Fulton Street shop, Adolph Levitt decided to show the public what the automatic machine could do—let them taste the doughnut so produced and thus create a popular demand for it. By 1928, the Display Doughnut Machine Corporation, now named the Doughnut Corporation of America, saw success looming. Eighty percent of its business was then in the New England States—the original home of the friedcake; and, strange as it may seem, the populace there was becoming "doughnut-conscious" in a way it never had been before. As expressed by an official of the concern: "Only a fraction of the public had (up to that time) really tasted doughnuts: and that fraction had been satisfied by Mom's homemade doughnuts, soft and fluffy little things that were eaten the day they were made. Those people could hardly be expected to find the soggy 'sinkers' then sold by some bakers at all palatable or desirable." Bakery-industry coöperation inevitably followed, and the doughnut attained a position it never could have reached had the old method of its production continued.

GRINDING FLOUR

At the right is a battery of machines that grind grain preparatory to sifting the flour from the grain kernels and bran. This is accomplished by passing the ground product through successive vibrating screens of silk gauze or bolting cloth. The worker below is inspecting one of these screens. The other picture shows various grades of material separated after the first grinding.

World War I had started the doughnut's climb, and World War II, through Red Cross units working in military areas, gave the much-improved cake wider recognition. In 1945, fifty million were served monthly to servicemen overseas! Machines, loaned by the Doughnut Corporation of America, were in use at fighting fronts in Europe, Africa, Asia, and on islands in the Pacific. One Red Cross girl, who saw service in North Africa and Italy, thus summed up her experience: "And how those men go for doughnuts! We handed out as many as 20,000 daily . . . . They eat 'em till you'd think they'd come out of their ears; and then they eat more. Lt. Gen. Mark Clark gave the order which moved Red Cross girls from bases, 30 miles from the firing lines, to foxholes. He declared them both expendable and necessary to soldiers' morale . . . . The girls never knew from day to day where they would spend the following night. They went through the same adventures as the men at the front—were bombed, shelled, and strafed."

The evolution and manufacture of the automatic doughnut-making machine is a chapter in itself, but it must be dealt with somewhat briefly because there is still another angle to the story as to how the wholesale production of doughnuts through applied engineering and chemistry has attained its present proportions. Along in 1925 the corporation decided to venture into machine constructior. Up to that time the capacity of the so-called Standard unit marketed by it was too large for the average shop and there was need for a machine that would turn out the approximate quantity a bakery could sell daily. The first plant was set up in a garage in Long Island City, N. Y., and there, with a second-hand lathe, an old milling machine, and one drill press, were assembled all the parts which were subcontracted to nearby machine shops. The first unit built—the Lincoln—was small, was heated by electricity, and had a mechanical doughnut cutter. It was easy to operate, but the result was not an overly good doughnut. Besides, it developed mechanical difficulties. But encouraging headway was being made, and one of the improvements was the use of air pressure instead of a cutter to form the doughnuts.

Relatively crude though the Lincoln was compared with modern units of that name, orders for 50 had been taken even before the first of that class was off the bench but not until it was evident that the difficulties were being mastered. At that stage, it became apparent that there was need for enlarged facilities for machine construction as well as for experimentation and that a palatable doughnut of uniform excellence was by no means a purely mechanical problem. The solution lay in a fully prepared doughnut mix, requiring only the addition of a prescribed amount of water to turn out a cake good to the last crumb.

That situation led to a connection with the old Gambrill Mills in Ellicott City, Md., about 10 miles from Baltimore. In 1926 the Doughnut Corporation of America purchased that concern's cereal plant, and four years later acquired its flour mill. The machine shop in Long Island City was then abandoned and a new one established at Ellicott City—fully equipped to manufacture and assemble all parts and to carry on essential designing and research work. Each new Lincoln was provided with a thermostat to regulate the temperature of the frying fat, and an air-pressure system was devised to control the size of the doughnut and to make them identical. But even with those gains some shortcomings persisted. In the third series of Lincolns the thermostat did not regulate the temperature of the fat close enough to cook the doughnuts properly, and the mechanical turner did not reverse them while frying so as to give them an all-over tempting brownness. Further, the batter would often be squeezed out between the dough-pan nozzle and the cutter instead of through the cutter.

With the doughnut's increasing popularity, it was clear that a new type of machine would have to be designed that would be more attractive in appearance

and that would satisfy the requirements of the wholesale baker. A bit of history will make this plain. Prior to 1928 the corporation had built several mammoth units such as the Premier and the Utility. The former could make 400 dozen doughnuts an hour, but was about 8 feet square and weighed approximately 4 tons! The Utility, though still overly heavy with its 3 tons, was 6 feet square and could turn out 225 dozen an hour. Those large-scale machines were useful in pointing the way to others that were less cumbersome and mechanically not so intricate.

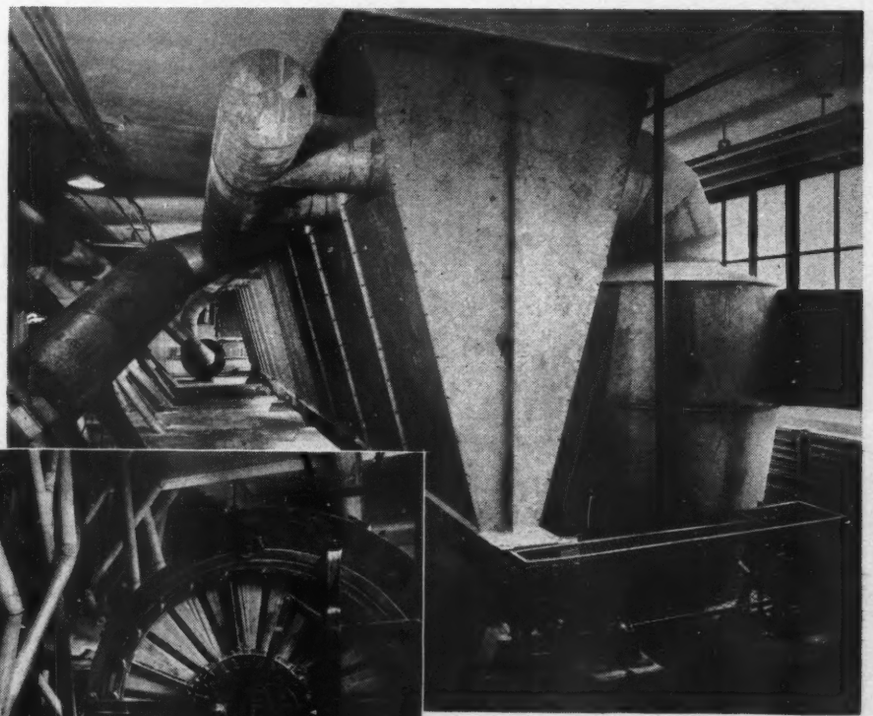
The first of the newer type was the Producer, a 2-cutter unit having a capacity of 160 dozen doughnuts an hour. It weighed 1500 pounds, cost less to build than its forerunners, cut more doughnuts per pound of dough, made better doughnuts, and made them faster. Before long, Producers were equipped with air-operated, constant-feed apparatus that takes the dough from mechanical mixers and feeds it to one or any number of machines, thus eliminating frequent manual refilling of their associate dough cans. Today, a number of machines of identical size can be run as a straight-line multiple unit and deliver their products to a group of auxiliaries that successively cool the doughnuts, sugar them, leave them plain or otherwise coat them, and then convey them to the packaging table where rapidly working operatives put them up for shipment. As an example of such a procedure we quote from a correspondent of the Doughnut Corporation of America who visited the Pacific area in 1945:

"Here in Okinawa, I found a doughnut factory with eleven machines in operation. Two shifts were running eight hours apiece, day and night, and almost supplied the needs of the island .... In Yokohama, there was a doughnut factory located in what had been a brewery. That building housed 24 Lincoln machines—twelve on each side of a long room. The factory staff was made up of 62 Japs supervised by Red Cross workers. In the center, between the two rows of machines, were the racks and mixing facilities. That unit made 50,000 doughnuts daily for the metropolitan area of Tokyo and Yokohama. Red Cross cars made deliveries over the region to spots where our troops were quartered. The longest haul was 50 miles." During the war, the corporation placed 300 automatic machines at the service of the Red Cross without charge and furnished the mix at cost.

Reference to the doughnut mix, of which there are several varieties to gratify different tastes, takes this story to Ellicott City. Successively since 1774, flour mills have stood on the site of the present up-to-date plant where they obtained their power from water wheels driven by the Patapsco River. Tradition has it that George Washington sent his wheat from Mount Vernon, Va., 50 miles distant, to be ground by the Ellicott Brothers. In 1941 the mill, then the property of the corporation, was gutted by fire and a new one reared and especially equipped to meet the company's diversified requirements.

Apart from the fact that a million bushels of wheat, grown on neighboring Maryland farms, pass through the plant annually in being transformed into premix flour, the establishment is interesting because of the continuous research carried on there for the purpose of developing ever-better doughnut-making machines and because of the laboratory work not only with doughnut mixes but also with premix flours produced there on a large scale for various other bakery commodities. Every one of their ingredients undergoes close scrutiny and chemically exact testing. Why this is so can be better understood when one learns that the aforementioned wheat flour is blended, among other things, with eight million dozen day-fresh eggs and 250 million gallons of prime milk—both of which are dried in the concern's widely scattered plants before reaching the Patapsco mill. Included in the ingredients may be the wartime substitute for cane or beet sugar—dextrose made from wheat flour. That chemical achievement, long sought for but elusive, won Government commendation. It was discovered by company experts in its Holland, Mich., plant.

The boxcars carrying the wheat are emptied by a pneumatic system that



TAKING OUT THE DUST

Dust produced during the grinding of the grain is drawn from the machines through ducts and delivered to the collector shown above. In some plant areas the duct system is a complicated maze (left).

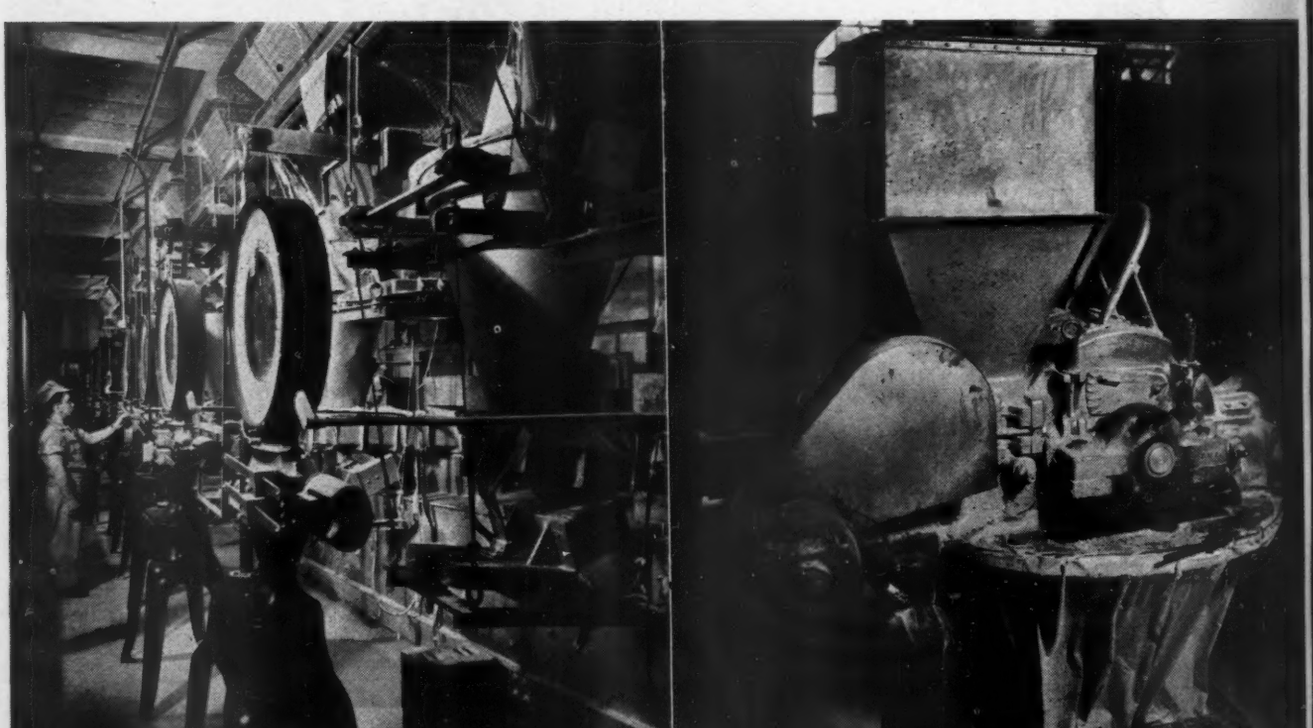
discharges into twelve towering cylindrical silos having a combined capacity of 450,000 bushels. As wanted, the grain is drawn off at the boot of each silo and raised by a bucket elevator to the top floor of the continuous 9-story mill. From there it begins its journey downward by gravity to the first floor, passing in succession through a series of cleaning machines that remove all foreign material and "scrub" the product in the process. During its travel the wheat is again raised, this time to the eighth floor, by a bucket elevator; and then it starts down once more by gravity, making a number of up-and-down movements in going through the milling process. In the course of this treatment the grain is subjected several times to grinding and sifting, and at each stage of the dual working it is elevated before again descending. By these repetitive operations the evolving flour is finally freed from any trace of wheat kernels.

Grinding is done with corrugated steel rolls that open up each grain so as to release all the flour within it, and in this manner are brought about conditions known to the trade as "breaks." Milling is seemingly slow, but this is deliberate, because the flour reaches its journey's end without heating that would impair its ultimate baking qualities. For sifting there are silk screens—bolting cloth of varying mesh stretched over rectangular frames. The sifters are boxlike affairs that contain up to a dozen screens placed one above the other, with the coarsest uppermost. The assembly is mounted in a manner that permits belt-driven cams to impart to them a jiggling motion. Any wheat that does not reach the bottommost or finest of the screens is automatically returned to the grinding section for retreatment before it is again delivered for rescreening. A flour mill is unavoidably a dust producer, and compressed air is made use of repeatedly either directly to clear machinery of dust or in a way to induce an aspirator effect, like a vacuum cleaner, where direct blowing is undesirable.

After the flour has passed through the final sifting operation, it is carried by screw conveyor up to the seventh floor where it is discharged into small feeder bins which, in turn, discharge into dehydrators on the floor below. These heated, revolving cylinders reduce the moisture content of the flour to the prescribed degree not only to prevent subsequent spoiling but to exercise a control that contributes to the quality of the baked product. The dehydrated flour next travels by bucket elevator back to the seventh floor where it enters Entoleters for aeration and sterilization. It is then in the proper condition for making one or the other of the premixes marketed by the corporation. From the Entoleters the flour is delivered to cylindrical bins or tanks on the same floor to await the mixing process. From seven to eight kinds are used for preparing the different mixes for doughnuts and the other specialties turned out by the bakery industry.

Sugar, spices, flavoring, salt, dried egg yolks, and dried milk, all of which have been carefully tested in the plant laboratory, also are available on the seventh floor. And on the same level are four large vegetable-oil tanks, each of which has a maximum capacity of 55,000 pounds. The "shortening," as cooks call it, reaches Ellicott City in a cooled state, and as its consistency and appearance are those of lard, it must be heated or melted for the mixing operation. Sugar arrives in granulated form and goes to a storage bin on the sixth floor from which it is raised by a bucket elevator to the seventh where it is held for delivery to grinders on the floor below. The purpose in pulverizing the sugar is to reduce it to a uniform grade of fineness that will permit of satisfactory distribution throughout the mixes.

The work of preparing the mixes is carried out on the fifth and fourth floors. The mechanical mixers used for the purpose operate in pairs—an upper section on one floor and a connecting unit on the next lower floor—and can batch from 75,000 to 85,000 pounds each hour. The ingredients for a batch are weighed individually either manually or by electronic scales that insure precise proportioning, a master push button bringing the automatic control into



PROPORTIONING PREMIXES

Ingredients other than flour, sugar, and shortening for various prepared backing mixtures are weighed by electronically controlled scales (left), and when all are ready, the push of a button starts them on their way to the mixers. One of the carriers that travel on overhead rails is seen at the upper right. The view at the right shows a pulverizer that further reduces granulated sugar so that it can be thoroughly distributed throughout the flour.

action; and fine wire screens serve to retain any foreign matter that may be present in the flour, etc. During batching, the vegetable-oil shortening is atomized by air and sprayed into the mix, to which may be added lemon, nutmeg, or some other flavoring ordered by the purchaser. The compressed air used in this division of the plant is supplied by a 15-hp., Type 40 I-R Motorcompressor.

A duplex mixer holds 6000 pounds and, as might be supposed, is loaded on the upper floor where the initial half of the operation is completed. The charge is then delivered by gravity to the lower section, where it undergoes further treatment. The entire mixing period is of about 40 minutes' duration and insures thorough blending of all the ingredients and consistently uniform batches that make for a product of corresponding excellence.

While the lower part of a duplex mixer is handling a charge received from the upper half, the latter is reloaded and starts on a fresh batch. Some of the ingredients are delivered to it by a lorry, but the larger volume—consisting of flour and sugar—is dumped into it by a hopper that travels back and forth on an overhead railway. Packing of the ready-mix flours is done on the fourth floor in special paper bags that have inner paraffin liners to keep moisture out and to retain the freshness of the contents. Both packaging and weighing are done automatically, and so too is the work of sealing.

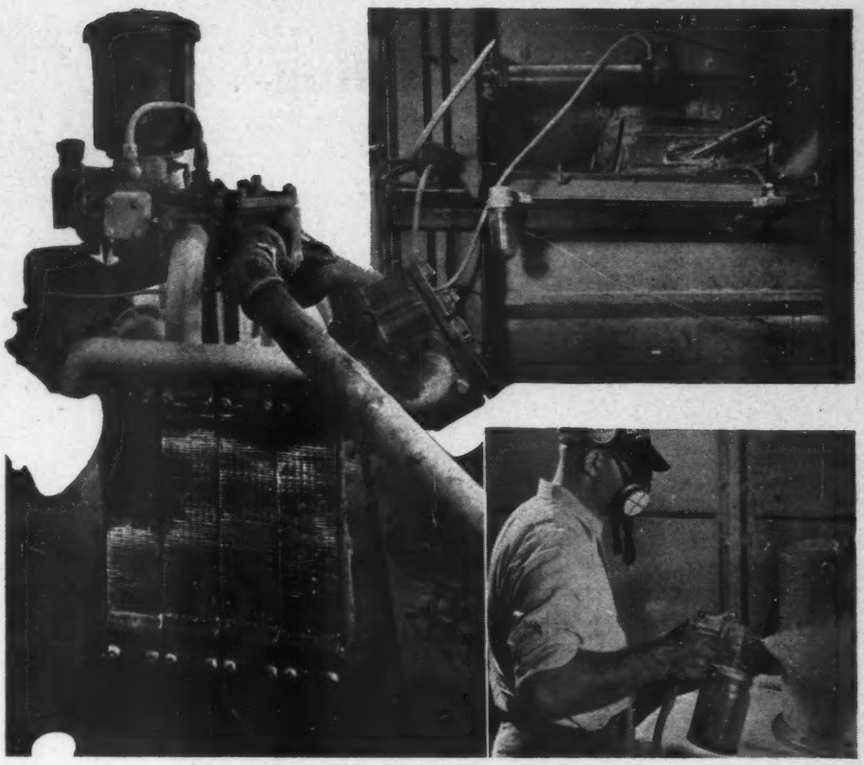
It is in the painstaking manner described that the Downyflake baking mixes of the Doughnut Corporation of America are made primarily for the "institutional market," by which is meant the bakery trade, hotels, restaurants, hospitals, educational institutions, etc. The general public obtains the ready-to-eat product of these mixes in the company's Mayflower retail sampling shops and through other established markets. Supplementing the making of delicious doughnuts in immense quantities daily—the original and dominant purpose of this nation-wide purveyor—are Downyflake mixes for egg pancakes, waffles, bran muffins, sweet-corn muffins, old-fashioned corn muffins, biscuits, pie crust, gingerbread, and white, yellow, spice, and coffee cake. And the research department is continually experimenting with still others for the grocer's shelves. On his visit to Ellicott City, the writer tasted a novel kind of cooky that seemed to him especially good.

As this article is primarily based upon mechanical achievement as a means of tickling the public's palate, let us have a look in the plant's well-equipped machine shop where the automatic doughnut-making units, ranging in productive capacity from 40 up to 600 dozen doughnuts an hour, are built. In it are rolls to form the sheet metal much used in the machines' basic structures, as well as boring mills, lathes of different types, drill presses, punch presses, etc. There is a nickel-plating department, a welding room, a paint shop in which the spray gun has plenty to do, an assembly department, and a testing floor where the finished apparatus receive their final check-up for mechanical fitness and for electrical control and functioning. This is vital, because the machines must operate with precisely coördinated steps; the temperature of the frying oil has to be maintained thermostatically at 375°F.; and the timing of the doughnut in that bath must be limited with equal exactness because the vegetable oil should penetrate only just so far into the dough when the heat has given the doughnut its golden brown crust, the stage which indicates that cooking is completed.

The machine shop's compressed-air requirements are supplied by a Type 40 Ingersoll-Rand unit; and in the foundry, where air under pressure is needed for sandblasting, grinding, and spraying the castings produced for the machine shop, there is still another Type 40. In the mill, compressed air operates some of the gates on the mixers; determines the level of the vegetable oil in the storage tanks; and also helps to do maintenance work such as piercing walls or opening up concrete floors. Then a pneumatic paving breaker is mustered into service.

The premix flour mill built by the corporation on the Patapsco River is said to be the largest of its kind in the world. It is a veritable monument to success in business—Big Business—created around the hole seen by the pessimist, but which Adolph Levitt, the optimist, realized was but an incident in the traditional form of the doughnut to which he dedicated his best in an effort to win for it nation-wide popularity.

Evidence of how well the work has been done is the change in the attitude towards the doughnut since 1920, when consumption was relatively insignificant. The number eaten last year was well over eight billion, and is on the rise! Today the corporation has branch offices in many of our large cities and is represented by subsidiaries in Trenton, Canada, and in London, England. And the doughnuts now available by reason of this far-flung enterprise are equal to the best produced by housewives really skilled in the art of baking.



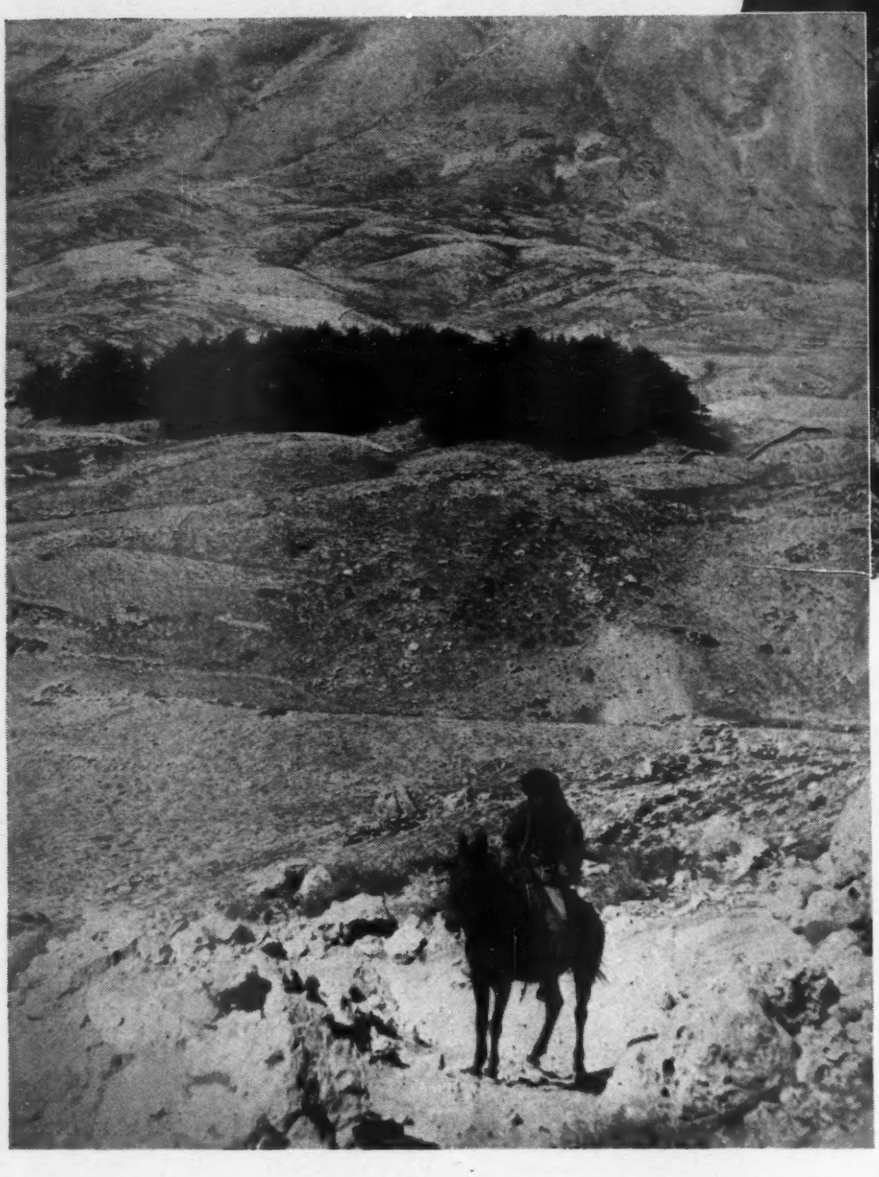
AIR SOURCE AND USES

Compressed air unloads the bulk grain from the cars in which it arrives, blows dust from machinery in the flour mill, runs pneumatic tools used in maintenance work, and performs other services. One of the latter consists in atomizing vegetable shortening and spraying it into the premixed doughnut flour. This is done by the apparatus shown at the top-right. In manufacturing the doughnut machines, numerous parts are spray painted, as illustrated at the bottom-right. Compressed air for all these purposes is supplied by several Ingersoll-Rand Motorcompressors, one of which is pictured at the left. This is a 2-cylinder unit with a piston displacement of 79 cfm.

Wartime Tunneling in Syria

Allen S. Park

KEYSTONE VIEW COMPANY



THROUGH the ages, tunneling has played an important part in military campaigns, and this was true in World War II, although perhaps on a comparatively smaller scale than previously, considering the magnitude of the recent conflict. Much secrecy still surrounds the Allied activities in various parts of the world and there may have been sizable tunneling exploits that have not yet been officially divulged.

Thus far, three important operations have come to light. One was at Gibraltar, where Canadian and British engineers carried on jointly. The Canadian activities there were described in our October, 1944, issue. A second operation, in Wiltshire, England, had to do with the defense of the island and has, so far as we know, never been written up in detail. As early as 1936 the Royal Engineers began converting mines near Corsham, from which building stone had long been extracted, into a storage depot for ammunition. Pillars that had been left to support the roof were encased in concrete, a tar-macadam floor was laid, and the section where cordite was stored was air conditioned. Following the outbreak of the war in 1939, a 1½-mile inclined tunnel was driven to provide safe haulage from the depot directly to the Great Western Railway line.

A third tunneling undertaking on which information is now available was carried out along the Mediterranean coast in Syria in 1942-43 in connection with the extension of the railway system linking Central Europe and Russia with Egypt. The work was done by the 61st Company, Mines Engineering Brigade, South African Engineer Corps. It was described in the June, 1947, issue of *The Journal of the South African Institution of Engineers* by L.D. Browne, who served as a colonel with the unit. The facts that follow were obtained from that source.

At the outset of the war there was a 150-mile gap between Tripoli, Syria, and Haifa, Palestine, in the standard-gauge railway system extending southward from the Turkish and Russian borders. Two months after the Allies occupied Syria in September, 1941, the joining of these transportation facilities was authorized. The building of a 92-mile section northward from Haifa to Beirut was assigned to the Railway Construction & Maintenance group of the South African Corps, and the remainder of the

SYRIAN SCENES

The Lebanon Mountains rise from sea level to an extreme elevation of 10,000 feet and their vegetation varies widely at different altitudes. The view at the extreme left shows a clump of cedars, which are a characteristic growth in the zone from Elevation 4200 to 6200. Syrians in the foothills of the Lebanons are pictured in the center. Most prominent among the ancient cities of the Phoenician Confederacy was Sidon on the Mediterranean (below) with Tyre as its rival. Homer wrote of Sidon's traders and artisans and Pliny credited the latter with the discovery of the art of making glass from sand. Sidon's present population is in the neighborhood of 12,000.

EWING GALLOWAY PHOTO

line to the Royal Australian Engineers.

The work allotted to the Australians included a stretch along the Chekka Headland, a part of the Lebanon Mountains. An inspection of the district indicated that one or more tunnels would be required to put through a line that would be relatively safe from enemy attack, and the Australians began making detailed surveys to determine what scheme would best fit the topographical conditions. In October, Major W.H. Evans of the 39th Railway Construction Company, South African Engineers, was instructed to inspect the area and recommend a tunneling plan. His suggestion of a 5740-foot tunnel was accepted, and the work was transferred from the Australians to the South Africans in view of the fact that the latter could call upon men from the Witwatersrand mines who were expert in underground operations.

Even though the job was to be done by miners who were still civilians in South Africa, Major Evans drew up a tentative schedule allotting twelve months to the project. He estimated that three months would be needed to get the men and plant on the site, six months to excavate the tunnel and have it ready for the passage of trains, and three months to line the bore and clear away the plant. On October 20, Major Evans revisited the headland with an electrical engineer who made an estimate of the materials that would be required to build an electrical transmission line from a cement mill to the tunnel site, a distance of some 3 miles. The construction of the line was then placed in charge of Major Duncan, with instructions to have it completed by January 15, 1942. Thereupon, Major Evans flew to South Africa to gather together the men and machinery to carry on the work.

Meanwhile, word had been conveyed to Field Marshal Smuts in South Africa that tunnelers would be needed, and the Chamber of Mines had indicated that the gold-mining industry would accept the responsibility of providing them and equipping them for their work. Recruiting was started immediately, and two days after Major Evans arrived the first members of the unit were enrolled. In anticipation of such a contingency, many men in the various mining districts had been assiduously following a military-training program in their spare time. Consequently, there were numerous volunteers at each mine. From them were selected those best qualified for the particular tasks to be done. A desire for travel and adventure, as well as attachment to their masters, also caused many native mine "boys" to volunteer. Although untrained in military discipline, their familiarity with mining practices made them valuable additions. In all, the unit just exceeded 900 men.

Concurrently with recruiting of the personnel, the huge task of getting together the necessary materials, supplies, and machinery for the job was being attended to. Under the direction of Capt. A.C. Backeberg, engineer officer, they were collected from mining areas in all parts of the Union of South Africa, and even from Rhodesia. This was done so rapidly that the full unit, along with 1100 tons of equipment, was ready to embark six weeks after the first call. It sailed on the S.S. *Eastern Prince* on December 12, and arrived in Beirut on January 12, 1942.

To this group was assigned the construction of 21,200 feet of railway along the Chekka Headland, which rises 600 feet sheer from the sea. The proposed and modified alignment called for two tunnels, one of 4813 feet and the other of 565 feet, together with heavy earthwork and retaining walls on the north and south approaches to the headland. Camp sites had been selected prior to the party's arrival, and Captain Backeberg had flown in ahead and arranged for the issue of rations, camp equipment, and stores, including winter clothing. Upon landing, the freight had to be transported 40 miles by road, and there were a few casualties to trucks because the South Africans were unfamiliar with the right-hand driving rule.

By the end of January, work was well underway on the two approach cuts and on two 8x7-foot adits to intersect the line of the main tunnel so as to divide its length into approximately three equal parts and thus afford additional driving faces. The north adit had a length of 200 feet, and the first 60 feet of it had to be spiled because it penetrated a fill carrying the main road overhead. The south adit was in the solid limestone of the cliff and was 300 feet long.

The north entrance to the main tunnel runs diagonally under the coastal highway, which had to be shifted slightly to permit construction of the first 190 feet of the tunnel by open-cut methods. This section was lined with 24 inches of heavily reinforced concrete, as there was a likelihood that the road

might have to carry 70-ton loads if it became desirable to move heavy tanks over it to the Turkish border. The cut had to pass through rocky talus at the foot of the headland and therefore presented difficulties. Good supporting walls were required, and these were built by Syrian masons who proved to be adept at the work. A quarry was operated to supply them with the necessary stone.

The south-approach cut in hard limestone had numerous clay pockets and crevices that impeded drilling, and it took five weeks to establish a face suitable for going underground. By March 7 tunnel driving was in full swing at five faces, and during the following ten weeks, to May 16, it progressed at the rate of 410 feet per week, or 82 feet per heading. The over-all time for the 4813 feet excavated was seventeen weeks.

Because compressed air was needed 24 hours a day, stationary water-cooled machines were selected, with sufficient portable units to serve during the installation of the main plant and for subsequent use at remote points. To meet the possible emergency of power failure, six compressors, with a total capacity of 1950 cfm., were fitted with dual motor and diesel-engine drive and provisions were made to change over quickly in case this became necessary. A compressor plant of 1100-cfm. capacity was located at the north portal to serve that heading and the north adit, a second one delivering 830-cfm. was placed at the south adit, and a third of 976-cfm. at the south entrance. Machine shops were established at the latter, but drill-steel sharpening was done at the north portal with two air-operated machines and one oil-fired furnace.

The principal equipment serving each of the five headings consisted of two 40-hp. scraper slides for loading muck, four hand-held rock drills, one 4-ton diesel haulage locomotive, and two 5000-cfm. ventilating fans. As no fresh water was available, sea water was used for cooling the compressor cylinders and also for drilling. This was elevated by two diesel-driven reciprocating pumps to a 15,000-gallon concrete reservoir at an altitude of 260 feet, from which it was piped to all working faces.

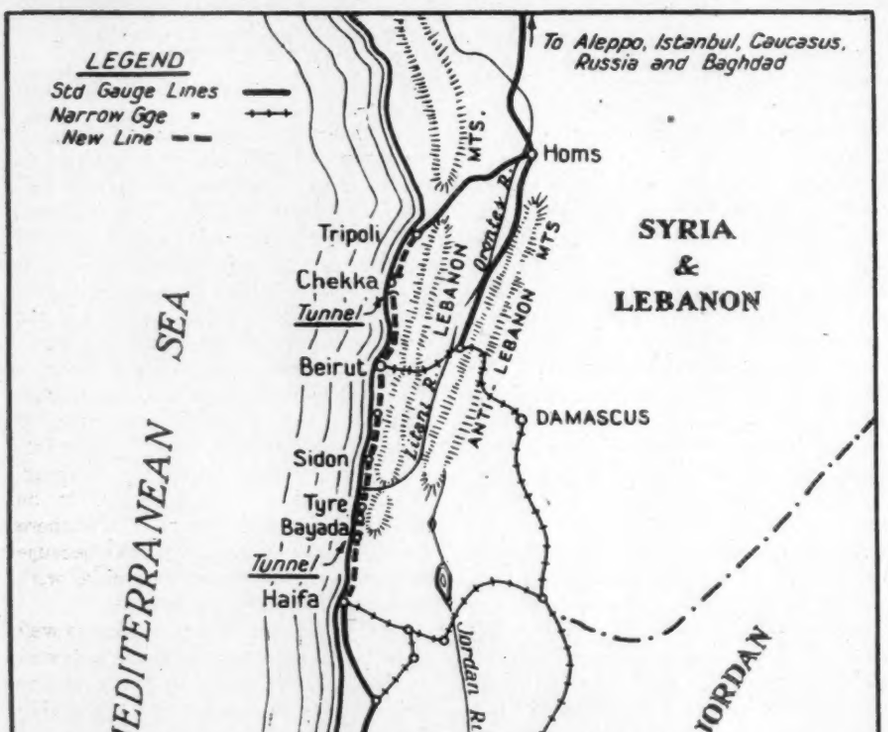
As excavated, the tunnel was 20 feet high and 15½ feet wide in straight sections and 2 feet wider on curves. It was advanced by carrying a top heading 10 to 12 feet ahead of a bench, permitting drilling forward while mucking was in progress behind. A normal round in the top heading consisted of 33 holes. These were put in easily with the four hand-held drills because the limestone could be penetrated at a maximum rate of 16 inches per minute. The bench was drilled in like manner with horizontal lifter holes. Hollow drill steel of ⅞-inch hexagon section was employed throughout. Blasting was done electrically with delay detonators, the job consuming 75 tons of explosives which had been brought from South Africa by the tunneling unit.

Muck was loaded into side-dump cars by means of scrapers pulled up slides by air-operated hoists. Two slides handled up to 500 tons per face every 24 hours. Muck trains were hauled out by diesel locomotives, and spoil was dumped down the side of the cliff into the sea. At one heading an advance of 628 feet was made in 31 days. With two loading slides in service, the average daily progress per heading was 17.04 feet. Where only one slide was used it was 11.74 feet per day.

The first 400 feet of tunnel at the northern end penetrated loose ground, consisting largely of big boulders that had slid down the cliff. It was necessary to support the top heading before the bench was excavated, and this had to be done concurrently with the advance. In the absence of steel sets, this was at first accomplished by timbering and then pouring concrete in the arch. This was a slow and laborious procedure, as equipment for conveying and pouring the concrete pneumatically was not available.

To save time, Captain Backeberg designed a precast-concrete arch rib 9 inches wide, 5 inches thick, and reinforced with four ½-inch rods. These were formed in a rigid cage on jigs, and as several thousand of them were required, a system of mass production was devised. Each rib weighed around 400 pounds. They were placed in pairs, one on each side of the arch beam. After the top heading had been excavated and lined, the bench was removed to vertical lines even with the inside edge of the arch lining. The sides were then undercut and concrete supports for the arch lining poured in 10-foot sections.

Other stretches of the bore where loose rock or mud pockets and fissures were encountered also were concrete lined. In some sections walls of precast-concrete blocks were constructed and the arch was



LOCATION MAP

It was of strategic importance during the last World War that the gap in the standard-gauge railroad system between Europe and Africa be closed. This 150-mile intermediate section had not been built before then because of the expense of negotiating difficult terrain along the mountainous coast.

poured. As long as this was being done near points of entry, premixed concrete was transported into the tunnel; but when the haul became longer and there was a chance of the aggregates settling, the mixers were set up close to pouring points. To speed the work, an apparatus was developed that became known as the "Do-little" because it left the men so little to do. It consisted of a concrete mixer mounted on a low-wheel chassis linked to a skip elevator built on a scraper-slide chassis. The entire unit moved on the 24-inch gauge track. Cars containing the raw materials were hoisted to dump directly into the mixer which, in turn, discharged into the skip. The latter was elevated and automatically tipped into chutes about 2 feet below the highest point of the tunnel arch. The chutes delivered the concrete by gravity, and it was pushed into the arch areas by the men.

The 565-foot Chekka south tunnel also was excavated by the methods just described, but it was advanced from one end only. As the site was too remote to connect it with the electrical transmission lines, power was generated by diesel-driven sets on the job, and compressed air was furnished by a 156-cfm. stationary machine and a 300-cfm. portable. An air-operated Cameron pump raised water from the sea to the tunnel level at Elevation 109, and another similar unit delivered it under pressure to the drilling face.

The Chekka tunnels were handed over to the Australian Engineers on September 1, 1942, seven and one-half months after the South African contingent landed in Syria. The entire rail line of 150 miles from Haifa to Tripoli was completed on December 20, and Field Marshal Alexander formally opened it early in 1943. More than 3200 feet of the bores had to be lined, and 1300 feet of that work was done after the road was in service.

As initially built, a part of the railroad between Haifa and Beirut was carried on a shelf cut into the steep face of the cliff. One section of it, about 1½ miles long, had sharp curves, was vulnerable to submarine attack, and could, possibly, have been damaged by undercutting wave action during stormy months. Consequently it was decided to run it through a tunnel—the Bayada Tunnel. This bore is 4162 feet long and it, too, was driven by the South African miners. It was attacked from both ends as well as through two adits—from six faces in all. During this period, Rommel was advancing toward Alexandria and Cairo, and as German reconnaissance planes began to appear over the area armed guards were stationed at the tunnel site. However, the undertaking was concluded without any untoward incident. The line was opened on May 4, 1943. Thus, within fifteen months after

EWING GALLOWAY PHOTO

LEBANON LANDSCAPE

A winter view on the eastern slope of the mountain range that parallels the coast line. The terraces are planted with mulberry trees that are vital to Syria's important silk industry.

their landing, the South Africans had built 9540 feet of railway tunnel, in addition to the approach sections.

This done, the workers were ready to return home, but that was not yet in store for them. In response to a request by the Middle East Supplies Commission to Field Marshal Smuts, they were given the job of driving 6000 feet of 8x8-foot tunnels included in an irrigation project between Tyre and Sidon. An access road of 3½ miles had to be constructed and the bores excavated and lined. A schedule calling for completion within 120 days was drawn up and was met by working 24 hours a day. The lining consisted of limestone rubble walls laid up in cement mortar, precast-concrete arches backfilled with concrete, and poured concrete inverts.

Another incidental assignment was the mining of lignite coal in the Lebanon Mountains by a detachment of 23 men. Operated previously by civilians using primitive methods, the mines had finally been closed because of the danger of complete caving. When, in August, 1942, it was decided to open a training school for ski troops at the Cedars, the visiting miners were asked to get out enough coal to meet the camp's winter requirements.

Although the equipment and supplies brought along with the tunnelers had been hurriedly collected in South Africa, it was found that those responsible had done a thorough job of planning. At no time was the work delayed for lack of materials, although ingenuity occasionally had to be exercised. When timber for the concrete-lining forms gave out, black corrugated-iron sheets were used successfully instead. Only ½-inch rods had been provided for reinforcing the concrete, and when it developed that they were too light for some purposes, many tons of them were converted into larger sections by twisting two of them together. Special devices were made to perform this operation quickly.

Those who had assembled the plant for the expedition had been mindful of the need for other than construction equipment. They had included, for instance, a large refrigerator that was much appreciated during the summer months. Also with admirable foresight, the adjutant had obtained a generous supply of the product of a Scotch distillery that was equally welcome during the wet and cold season. To avoid questions, this was officially listed as "red ink."

The South Africans found the Syrian climate austere. Rain came down for days at a time and was driven almost horizontally by high winds. In the summer the temperature was above 100 degrees for sustained periods. The salt-water ponds along the seafront bred myriads of mosquitoes, and local records indicated that the incidence of malaria among the natives was around 80 percent. However, only about 2½ percent of the tunnelers were affected, thanks to effective counter measures taken by their Hygiene Section. Other major irritants were all sorts of insects and athlete's foot. The latter was brought under control only after each man had been given a pair of wooden sandals to wear in the shower baths. Despite all the unfavorable factors, there was only one death among the entire personnel, the victim being a South African native who succumbed to natural causes.

Boring for Water Connections with Air Power

TO REDUCE the amount of trenching needed to put in water-service connections from street mains to new buildings, a method of boring horizontal underground holes with air power has been developed by the water-works department of the Woodstock (Ont., Canada) Public Utilities Commission.

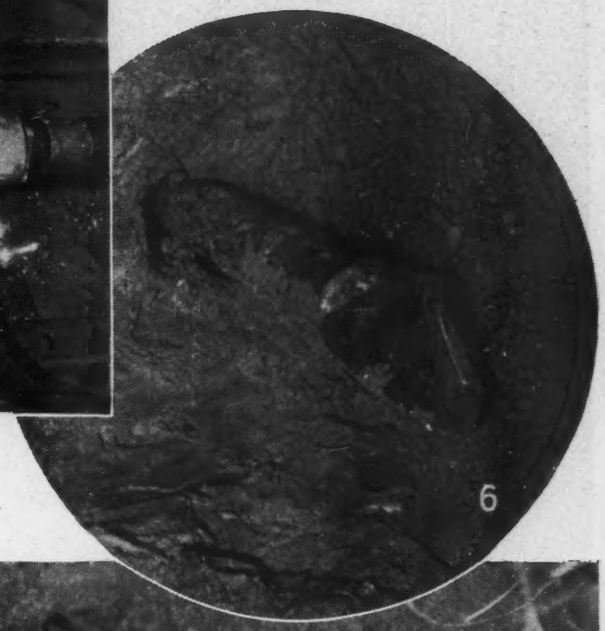
When a home or other structure is being erected, water service is one of the first requirements of the building contractor. Providing it has traditionally called for opening up the street to lay a lateral pipe line, a procedure that not only consumes much time and labor but also tends to impede traffic temporarily. After the pipe is in, the trench has to be backfilled; and if the street is paved, its restoration to the original level and appearance without the incidence of subsequent settling involves painstaking and costly work.

Faced with the necessity of supplying a considerable number of new homes with water, the Woodstock Commission, under the direction of Manager J. R. Sullivan, devised the new method to reduce costs and also to expedite operations. The equipment used consists of a small portable air compressor, a rotary air drill, sectional drill rods, and a simple fishtail bit.

The procedure calls for the opening up of two trenches: one only 5 or 6 feet long to expose the water main at one end, and another shorter one at the curb line where the control-valve box is located. Working in the street trench, the main is drilled and tapped and a connection inserted to provide water needed by the drilling apparatus in penetrating the ground and to wash cuttings from the hole. The drill used is of the Canadian Ingersoll-Rand Multivane reversible type and is fitted with a No. 4 Morse taper socket by which connection is made with the drill rod. The tool is rated at 3.7 bhp. at 90 pounds air pressure and a speed of 160 rpm. It has a rolling throttle that permits governing the speed, as may be desired.

The drill is mounted on a base plate that is free to slide along a structural-steel platform. A row of holes a few inches apart is bored in the surface of the platform along both edges, and a 2-pronged wire, affixed to the end of a handle, serves to push the drill ahead. This is done by inserting the prongs progressively in opposed pairs of holes and pressing forward on the handle, which bears against the drill, as shown in an accompanying illustration. To keep the drill rod on the predetermined line, it is supported at the forward end of the platform.

The drill rods are heavy-walled 1½-inch pipes cut in 4-foot lengths and threaded for coupling. The cutting element or bit fastened to the forward end is a twist drill made from a piece of carbon steel 3 inches wide, ½ inch thick, and 9 inches long. It was given a quarter turn and sharpened. When boring is to begin, the platform is lowered into the street trench and leveled, the drill is mounted on it, and air and water hoses



TOOLS AND PROCEDURE

1. Lighweight portable compressor and trailer with tools, ready to be towed to a job. 2. Close view of tool carrier, with all equipment compactly stowed. Threaded ends of drill-pipe sections are shown. 3. Demonstration set-up of air drill, one length of drill pipe, and bit mounted on platform and with air and water hoses connected. The operator is showing how he moves the drilling assembly forward with a pusher at the base of which are two prongs that fit into holes along each edge of the platform. 4. The same assembly at work in the bottom of a trench starting to bore a hole underneath a street surface. 5. Close-up of the drill. Water connection is at the right and air connection at the top. 6. Fishtail bit emerging from end wall of trench at curb line after having penetrated intervening earth. 7. Copper tubing for water service has been attached to drill pipe and, by reversing the air drill, is being drawn back through hole to trench at the main.

are connected. The first piece of drill pipe is then attached and lined up so that the hole will be driven in the right direction. As boring proceeds, additional 4-foot lengths of rod are added. After the bit has penetrated to the trench at the curb line, it is removed and a copper pipe, that is to serve as the water carrier, is attached to the drill pipe by a universal coupling. The drill is then reversed to draw the rod back through the hole, bringing the copper pipe with it.

Compressed air is supplied by a trailer-mounted Ingersoll-Rand portable unit, and the drill, drill rods, and accessory equipment are stowed in a small trailer built to carry them. The whole outfit can be towed to and from jobs quickly.

The city of Woodstock has put this apparatus to good use since it was developed in the fore part of 1946. A considerable increase in industries and population has been registered there since the close of the war and this made it necessary to drill and connect three new wells in the spring area, 4 miles from the community, that is the source of its water supply. More than 100 homes were constructed in 1946, and to provide them and the new business and industrial establishments with water, some 6800 feet of mains were laid last year.

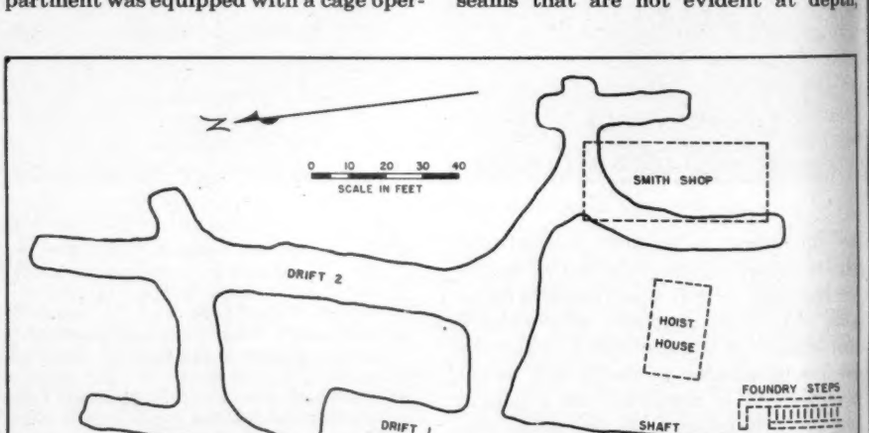
Mining at a Snail's Pace

Walter P. Gillingham

PROFITABLE mining under current conditions requires high output with minimum cost per ton of production. Efficient methods are called for at every step in the procedure, including a drilling program that permits breaking a given volume of rock with the fewest possible blast holes. Strict adherence to these principles would seem to be necessary if a mine is to be worked successfully, and yet there is at least one property that deliberately ignores this fact. The latter has no ore deposit and is not concerned with production. Its miners drill as many holes as they can in the exposed rock face before blasting to expose a new one. Consequently, actual removal of rock is held down as much as practicable, and during the more than 35 years of operation only some 3000 cubic yards of material has been extracted. Despite all this, and silly as it may sound, the owners consider the mine a paying investment.

Located in Phillipsburg, N. J., the mine was opened by Ingersoll-Rand Company for use in testing rock drills under conditions closely akin to those they encounter in the field. Rock drills, drill rods, Jackbits (detachable bits), and mountings of new design undergo rigorous tests there to determine their fitness. Machines are often operated 24 hours a day for several months to subject them to the wear they would receive over a period of years in actual service. Periodic dismantling of the machines during the tests discloses weak points in design or construction that must be remedied. Altogether the mine has been of material aid in the development of many improvements in rock drills and associate facilities.

Actual work on the mine started around 1910 when a small, 2-compartment shaft was sunk to a depth of 50 feet on company property. One compartment was equipped with a cage operated from a hoist house on the surface, and the other with ladders to serve as a manway. The rock is a thickly bedded blue limestone that dips approximately 30° in an easterly direction. Covered with 7 feet of overburden, the formation is highly faulted and fractured near the surface and characterized by many open seams that are not evident at depth,



PLAN OF MINE

In 35 years of operation, drifts and crosscuts have been advanced a total of less than 650 feet, thus probably setting a record for slow mining. However, by utilizing every square foot of rock face to the utmost, many miles of blast holes have been drilled and the testing ground has played a vital part in improving the design and construction of rock drills and allied equipment.

ABOVE AND BELOW GROUND

1. Overhead drilling with an automatic-rotation R-58 Stopehamer. 2. Putting in lifter holes with a D-505 power-feed drifter mounted underneath a column bar. 3. A group of student engineers in front of the headframe. The hoist house is at the left. The cage carries six men. 4. A JB-4 Jackhamer on a Jackleg for light drifting work. Two of these pictures show the close spacing of holes by which blasting is deferred as long as possible.

where the hardness and uniformity of the limestone make it an excellent drilling medium.

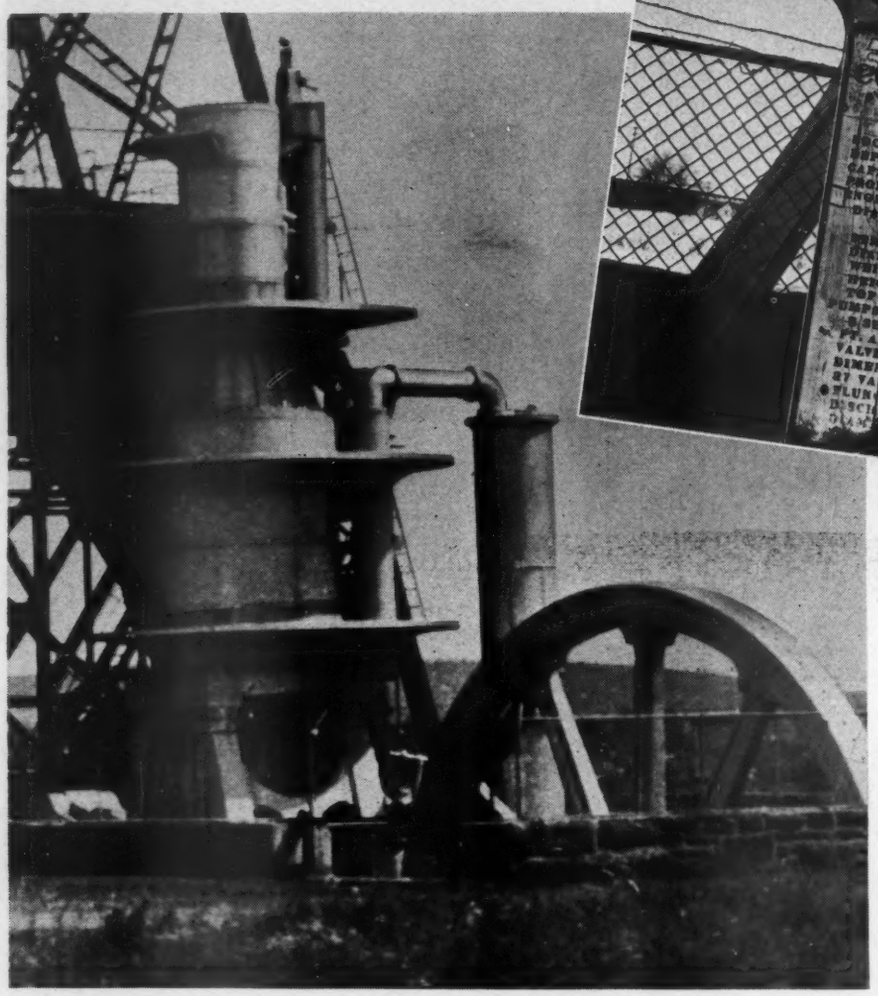
Drifting in a southerly direction was begun on the 50-foot level, but it was hastily abandoned when irate workers in a nearby foundry complained that blasting caused their sand molds to collapse. The shaft was then deepened to 100 feet and a drift driven in the opposite direction. Since the purpose of the mine is merely to provide a place for drilling rock, no plan of development has been followed.

As the mine grew in size, it became evident that a second entrance and exit was needed to serve both as a ventilating shaft and as a manway. After considering the fractured nature of the formation near the surface and the cost of sinking a shaft by conventional methods, it was decided to drill a hole that would be large enough for the purpose by means of a Calyx drill equipped with a 36-inch-diameter core barrel. As the rotating barrel cut a smooth hole through the limestone the core was lifted out in sections. The bore tapped the workings at a point 3 feet from the wall of one of the drifts, as planned. Provided with a metal ladder, the shaft now stands without a stick of timber to brace it, whereas a shaft sunk in the customary manner would have required timbering to support the rock shattered by blasting.

Air to operate the drills in the mine is supplied by the main compressor plant on the property. One-hundred-watt light bulbs strung at close intervals throughout the drifts eliminate the necessity of using miners' lamps. A Cameron reciprocating pump, located near a sump at the bottom of the main shaft, serves to dewater the workings. Blasting and mucking operatings are contracted to groups of men who are called in when there is need for their services, which is infrequent. Muck is hand-shoveled into wheelbarrows which are hoisted by the 6-man cage in the main shaft and run to disposal areas on the surface. The cage is equipped with safety devices, as well as a signaling system and telephone that permit continual contact with the hoist man.

In addition to serving as a proving ground for rock drills, the mine gives student sales engineers an opportunity to become familiar with the products they are to handle. Each student receives instruction there in the operation, maintenance, and repair of all types of rock drills. It is also used by established rock-drill salesmen who return to the plant for a refresher course. Although it has yet to show a cent of direct monetary profit, the mine pays off in indirect benefits, which are of appreciable value. Mine owners who are plagued with labor shortages and rising costs may well have reason to envy the status of this mine, which is undoubtedly the world's most inefficient.

Old Pumping Engine



Preserved for Posterity

Paul C. Ziemke

BEHEMOTH OF PUMPS

Close view of the above-ground part of the gigantic engine, with the base of the mine headframe in the background. The sign (upper right) gives information about the pumping unit and its performance. Above the sign may be seen one of the metal links by which sections of the 40-foot flywheel were joined together.

PERSONS passing through the little mining city of Iron Mountain in Dickinson County on Michigan's upper peninsula are struck by the unusual sight of a gigantic pumping engine, the last remaining bit of tangible property of the once busy and prosperous Chapin Mine. It stands beside the collar of the abandoned "C" or Ludington Shaft, only a short distance from the business section of the community and within a stone's throw of the state highway leading up into Michigan's famous copper country and to the College of Mines and Technology at Houghton.

When the mine's iron-ore reserves were exhausted, the Oliver Mining Company (United States Steel Corporation) deeded the surface plant to the trustees of Dickinson County, with the thought in mind of preserving it as a memorial to the early mining days on the Menominee Iron Range. The steel headframe remained in place for many years as a companion piece to the pumping engine and was dismantled only to help meet the nation's urgent need for scrap metal during World War II. With the removal of the enclosing building by its former owners, the engine was at the mercy of the elements. It was therefore given two coats of protective aluminum paint, which both adds to its appearance and causes it to catch the eye of passing motorists.

The machine is the 1891 version of the Cornish pumping engine, which owes its name to having been initially used to pump water from the mines in Cornwall, England. It was intimately associated with the development of the earliest practical steam engines. The first one was invented by Thomas Savery in England in 1698, but it had no cylinder or piston. Instead, steam was forced into a chamber, where it displaced water, and was then condensed. The resultant vacuum drew water up through a pipe by suction when a valve was opened. Intermittent pumping was achieved by repeating the cycle over and over.

The original piston-type engine was Thomas Newcomen's creation of 1705, which served to pump out mines around 1711. Steam was introduced underneath the piston in a vertical cylinder to raise the former and was then condensed by injecting cold water, thus inducing a vacuum. Atmospheric pressure on top of the piston then forced it downward. James Watt made Newcomen's engine more practical in 1763 by adding a separate condenser and an air pump to evacuate it.

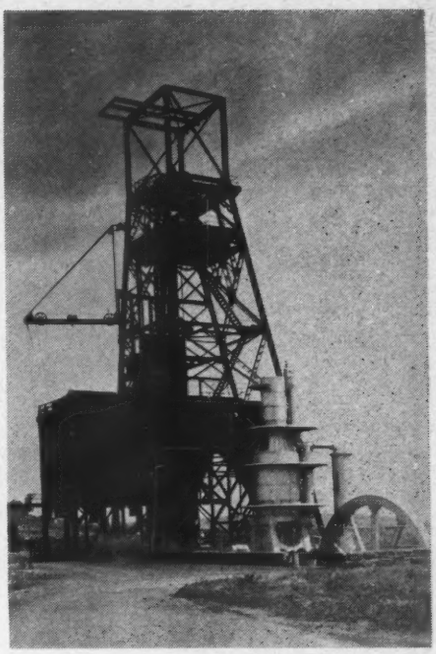
Watt's machine had one single-acting cylinder. In 1781, Jonathan Hornblower improved upon it by devising a unit with compound cylinders, located side by side and operating on the same end of an overhead beam. To the opposite end of the beam was attached a coupled pump rod that extended down into a mine to work a plunger pump at the bottom of the shaft. The Watt interests stopped Hornblower from manufacturing his invention because his use of a separate condenser and associate air pump infringed on their patents. Accordingly, single-cylinder engines continued to serve the mines until Arthur Woolf revived the compound principle with a unit that was

introduced in Cornwall about 1814. It was popular for a short time, but was soon supplanted by a single-cylinder engine of simpler contruction invented by Richard Trevithick.

Many of the latter machines carried greater loads than those for which they were designed, and around the middle of the nineteenth century John McNaught conceived the idea of increasing their capacity by adding a second cylinder. Steam at a higher pressure than had been used was admitted to this cylinder and passed from it to the original cylinder, which became the low-pressure member of the thus compounded unit. Many engines that did not have sufficient power for the work they were called upon to do were "McNaughted" in this manner and were found to deliver more energy and to show a greater fuel economy than before. Thus the principle of compounding was firmly established, and with the development of facilities permitting the application of higher-pressure steam it came into more general use.

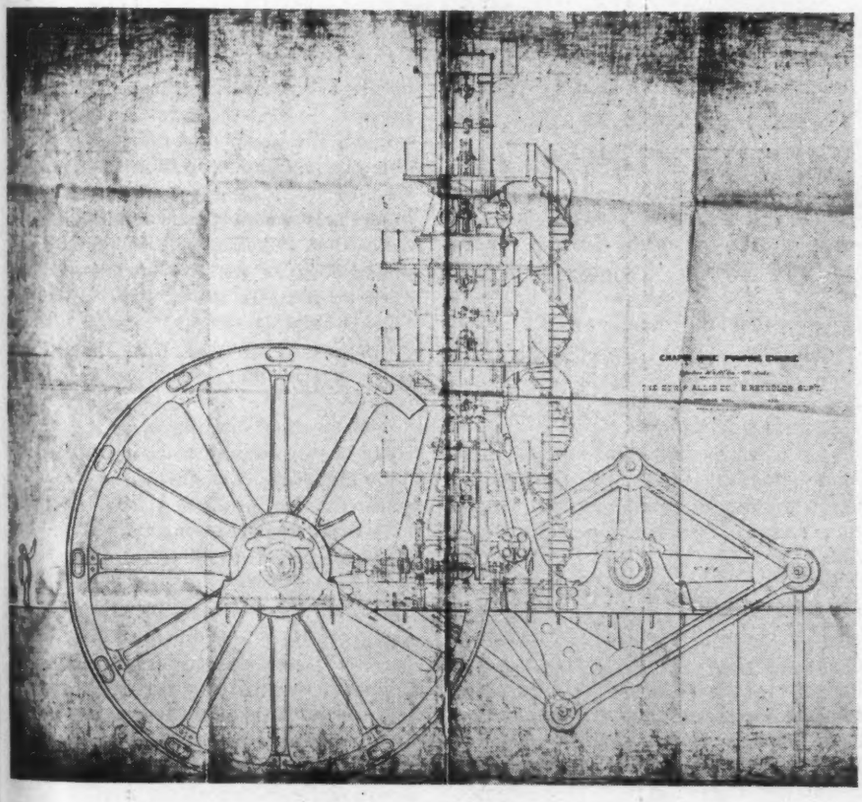
The Cornish method of pumping persisted until compact pumps that could be lowered down the shafts were designed. The one at the Chapin Mine was built by the E. P. Allis Company of Milwaukee, Wis., and is reputed to have been the largest of its kind. It towers 54 feet into the air, and the bottom of its 40-foot-diameter flywheel is 16 feet underground, making a total height of 70 feet. It weighed 160 tons when in working order. The low-pressure cylinder is 100 inches in diameter and the high-pressure cylinder 50 inches, and they are arranged in a vertical line with the piston acting directly upon the pump rod that extends down the 1659-foot shaft. The piston stroke was 10 feet. Water was elevated in stages, and of the ten pumping units in the shaft eight were at intervals of 192 feet and two at 170 feet. The capacity from a depth of 1500 feet was 3000 gpm.

It is interesting to note details of the engine's construction. There is a total absence of welded joints, which are so common in modern machinery of all kinds. Accompanying illustrations show how sections of the huge flywheel are fastened together. It was the author's first assignment on an erection job to haul in the blacksmith's forge that was used to heat the connecting links preparatory to placing them on offsets located near the periphery of the wheel. As the links cooled, the segments became a wheel that could be taken apart only by the then laborious method of cutting the connecting elements in two by hand tools.



ENGINE AND HEADFRAME

The headframe was removed during the scrap-metal drive of World War II.



FACTORY PRINT OF UNIT

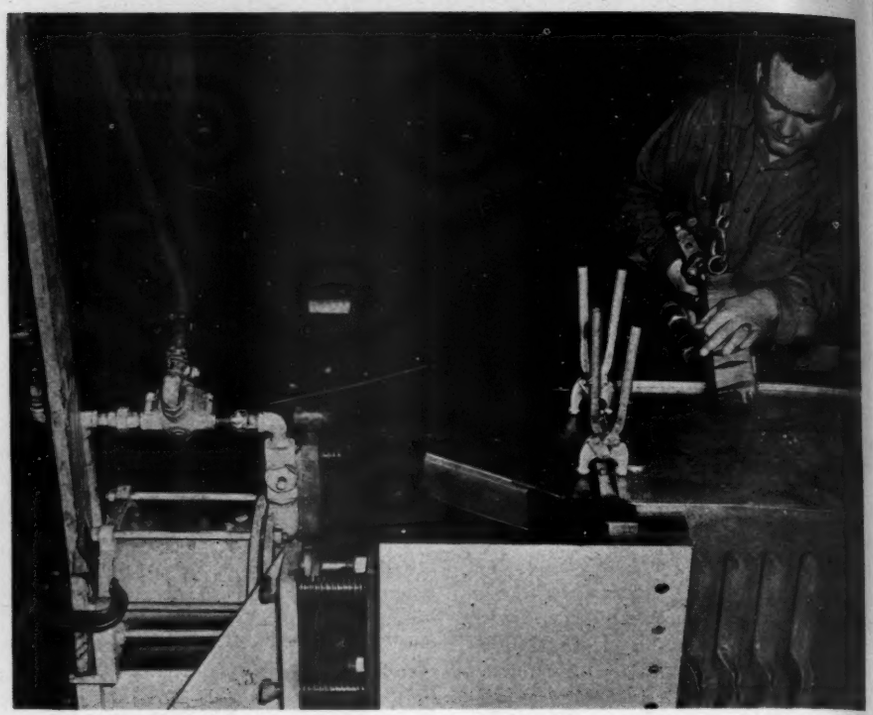
The drawing was made in 1890, the year before the pumping engine was built. It bears the name of Edwin Reynolds, an authority of that day on large engines and chief engineer of E. P. Allis Company. The latter firm, predecessor of the present Allis-Chalmers Company, supplied engines of this same general type for driving some of the first Edison bipolar dynamos. Many of them generated power for electric railways here and abroad. Those installed in the Interborough Subway powerhouse in New York City are still in operation. Note the comparative size of the man at the left.

The once brilliantly polished brass railing that wound majestically up along the cast-iron stairs has been carried away piecemeal by vandals or curio seekers in spite of the 10-foot fence provided by the authorities of Dickinson County, and other acts of demolition have defaced the once proud old lady. Yet she stands quite serene out there in the vastness of the once busy mine site as if knowing that her equal in size was never seen elsewhere.

Stories persist among mining men, as stories do, that the laminated wood rod of this behemoth of pumps, extending down fully 1500 feet to link up the several pumping units, was provided with ladder rungs so that men could enjoy the lift of the 10-foot stroke in leaving the workings. This, however, is not true, according to former owners. The tale perhaps gained credence because some Cornish-type pumps in England are reported to be arranged so that miners can ride them in ascending the shafts.

As one gazes at the once glistening and outstanding example of the mechanical engineer's skill, one's thoughts drift back to the operating engineer of that early day in mining history at Iron Mountain. We can picture him climbing ceremoniously up the winding stairs of his new and powerful charge to check packing glands and lubrication 54 feet above the engine-room floor. A man could be proud of a responsibility like that, and we can be assured that the beautiful big machine got the loving care she deserved.

Air Power Helps Odin Build Kitchen Ranges



AIR-OPERATED FIXTURES

The assembly that is being spot-welded (left) is clamped to a table jig by L-shaped arms near the four corners of the frame. The control valve at the right of the frame admits air to a cylinder that is underneath the table and the piston of which is connected with the clamps by four jointed arms. The view above shows a bending fixture used to form ovens and storage compartments. The pneumatic cylinder that provides the power for bending the sheet steel is at the lower left. The top and side members of a stove compartment are in the machine and are being tack-welded.

LESSONS learned during the war are serving to improve the peacetime manufacturing methods of the Odin Stove Company of Erie, Pa. Although never unprogressive, this concern, nevertheless, profited by its wartime experiences and was quick to turn them to advantage when it reconverted to its regular work. During the conflict, Odin's plant was devoted entirely to making ordnance for the Government. Its products included Navy conduit boxes and ship cargo doors, as well as panel and section assemblies for Army C-46 and P-47 airplanes. The Army-Navy E and other awards were granted to the company in recognition of the excellence of its work.

When peace was declared the management prepared to return to stove making, but not in the old way. C. H. Hoffstetter, president and general manager, and his brother, R. F., vice-president and treasurer, summoned Chief Engineer Harry Farnstrom and other plant executives and told them in effect: "We learned a lot during the war about high-quality and precision manufacture on a mass-production scale. With a little study and planning, we ought to be able to put this know-how to work producing not only more but better stoves than ever before."

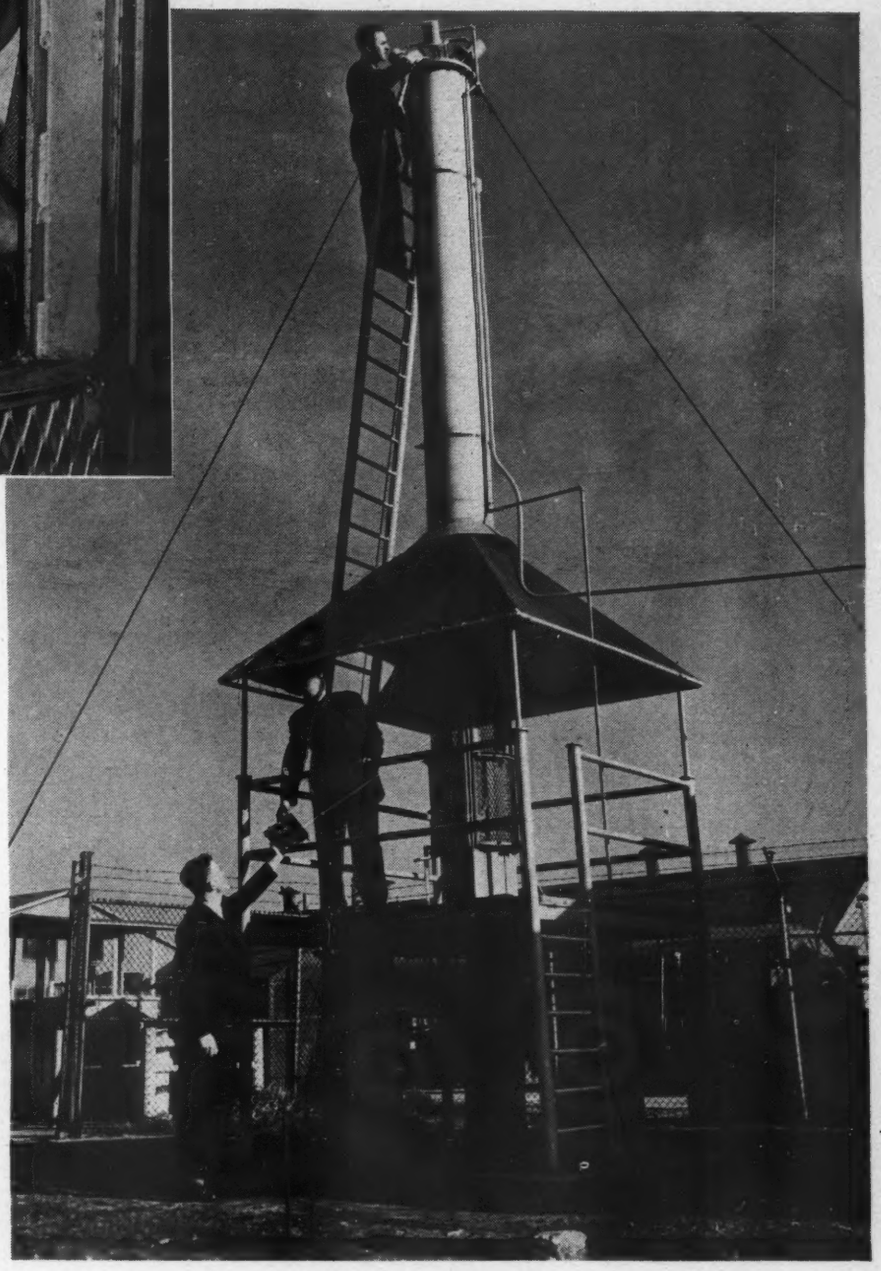
They started out by departmentalizing the factory from the receiving section on one side to the shipping area on the other. Within each department, everything was laid out to promote easy flow of materials. Assembly-line methods were instituted wherever possible, and many sections were reëquipped and retooled to increase efficiency. Among the new procedures adopted are many that use air-power advantageously. In one instance, pneumatic fixtures and tools have aided manual effort to such an extent that two men are now able to perform as many as seven operations simultaneously.

Perhaps the most striking example of the effective employment of compressed air is in connection with the fabrication of stove-body parts. Mr. Farnstrom and his associates have devised a fixture that reduces the forming of the range oven to a few simple steps. Air pressure, brought to bear through a cylinder and piston and regulated by a speed-control valve, bends 20-gauge steel around a die to shape part of the oven. Then it holds the piece while the lining is spot-welded to it to make a complete unit. Other equipment in this department includes an air-operated machine which forms 18-gauge steel into base sections for ranges, a corner at a time. Still another uses air pressure to grip parts to be welded and to eject the completed fabrication.

In the machine shop there is an air vise that clamps material for deburring, while pneumatic synchronizers serve to control drills that put from 10 to 58 holes in pieces such as the top burner and the oven burner. In use at appropriate intervals along the final assembly line are air-driven hand tools that drill holes, drive screws, and squeeze rivets in fitting the various parts together. Conveniently near the line is a huge stockroom from which are trundled the many odds and ends that go into the making of the finished product.

Recognizing that even the best-organized and best-equipped factory still depends upon the human element for optimum functioning, the management has given its attention to making working conditions and the environment as favorable as possible. Gas-hot air heating units suspended from the ceiling assure winter comfort, come what may in the way of Lake Erie weather. Where necessary, sections of the roof were removed and cupolas and window sash built in to give adequate natural lighting. Work halts every morning at 9:20 for a short rest period, and a cafeteria has been provided to supply coffee and doughnuts to those that have not brought a snack from home.

Air Gun Tests Airplane Devices



NEW airplane control devices are tested under conditions of extreme acceleration by a pneumatic mortar built by the Boeing Aircraft Company. Designed primarily for the purpose of evaluating the performance of electronic and mechanical components of Boeing GAPA (Ground to Air Pilotless Aircraft) guided missiles, the air gun has proved itself invaluable in the development of this latest defense weapon.

The mortar consists in the main of two cylinders arranged vertically and enclosing a car or cartridge, which is projected from the lower into the upper cylinder under the impulse of compressed air. Equipment to be tested is mounted on the car, which is lowered into firing position after safety gates are closed and which is held in place by a trigger catch. Air is then admitted, and when it reaches a predetermined pressure the trigger is pulled, causing the cartridge to shoot upward. Full speed from standstill is attained in 9 inches of travel, and a cushion of air, compressed in the upper cylinder by the car itself, slows down and stops the latter within a range of 90 to 100 inches! Four valves at the muzzle of the gun allow the air to escape gradually, thus limiting deceleration of the cartridge to a rate about one-tenth that of acceleration.

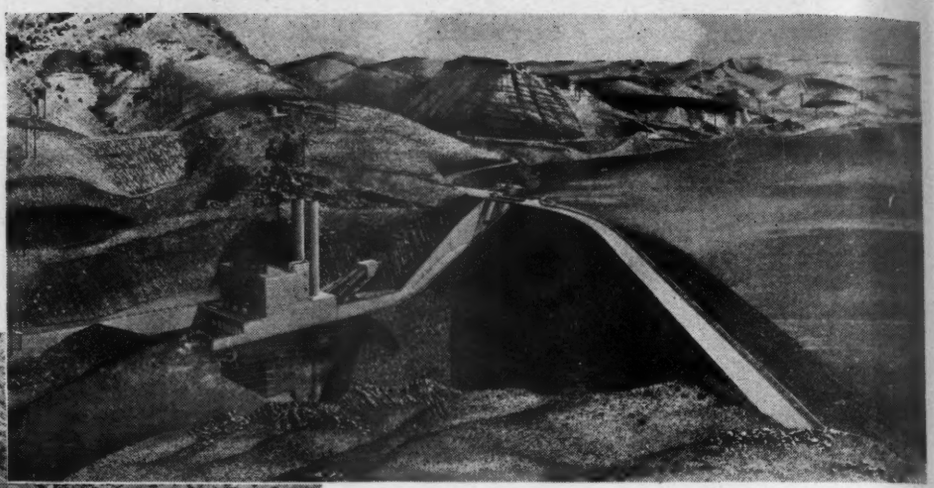
Behavior of the devices, which are operated at capacity during the entire procedure, is recorded by an oscillograph for careful study. High- and low-power voltage is carried to them by a flexible cable, which spirals down to the car from the top of the upper cylinder. Output current from the equipment is conducted back through the cable and into a nearby laboratory from which the tests are controlled.

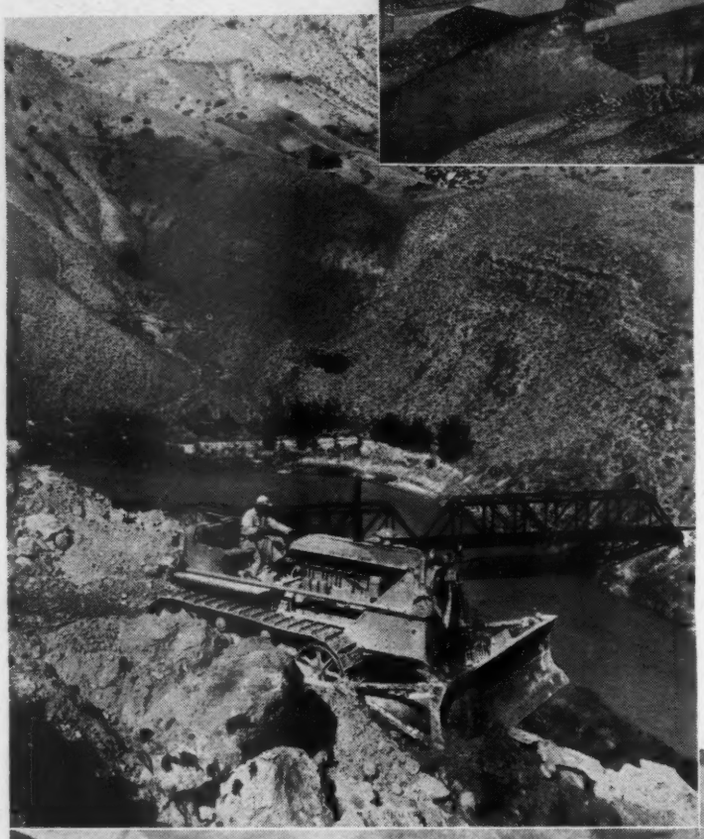
Firing as much as 50 pounds of equipment at a maximum speed of 50 miles an hour, the mortar can subject it to 100-G loads (100 times the force of gravity). Cartridge and load together weigh about 250 pounds; but during a 100-G test their weight is, in effect, 25,000 pounds the instant the trigger is pulled, and the downward thrust of that load is actually transmitted to the concrete and steel foundation of the weapon. It is reported that the latter has revealed many vital and interesting facts since it was put in service early this year.

GIANT AIR GUN

Twenty-seven feet high, this Acceleration Test Mortar has fired many "rounds" in determining how rheostats, potentiometers, condensers, vacuum tubes, and other aviation equipment will perform in actual service. Compressed air is used to fire the gun, which is loaded from the platform. The man on top of the ladder is checking valves that control deceleration of the cartridge so as to bring it to a safe and gradual stop. The ends of the carriers are arranged to act like pistons. The picture at the top shows a new device being mounted on the cartridge, which will be lowered 9 inches into starting position after the gates (bottom) have been closed. The operating air at 100 psi. pressure is piped to the contrivance from the regular plant distribution system.

Preview of Boysen Dam, Wyoming





WILL HELP CURB MISSOURI RIVER FLOODS

BOYSEN DAM, to be built on the Big Horn River at a point 18 miles south of Thermopolis, Wyo., is the first U. S. Bureau of Reclamation structure to go forward under the President's program to expedite the Missouri River Basin flood-control project. Morrison-Knudsen Company of Boise, Idaho, was awarded a $13,900,000 contract on September 4 to construct the dam and a 15,000-kw. powerhouse at its downstream base and to relocate 14 miles of Burlington Route tracks. The dam will be an earth-fill structure 150 feet high and 1000 feet long at the crest. The 31,000-acre reservoir behind it will store 1,493,000 acre-feet of water, which will irrigate 20,000 acres of now uncultivated land, regulate the stream flow to increase irrigation downstream, and catch silt which has previously clogged farmers' ditches. The power will relieve a shortage in the area. With Moorhead Dam on the Powder River and Mission Dam on the upper Yellowstone River, Boysen will curb floods that this year alone caused $1,000,000 damage. The picture below shows the dam site (midway between the two sharp bends in the foreground). A drawing of the dam and powerhouse is seen above. In the center view a bulldozer is at work moving dirt to rebuild, on higher ground, the highway that now flanks the river.

BUREAU OF RECLAMATION PHOTOS

Electroless Plating of Metals by Chemical Reduction

METAL surfaces can be plated with nickel or cobalt without the use of electric current, according to a recent announcement by the National Bureau of Standards. Designated as electroless plating, the process was developed by Abner Brenner and Grace E. Riddell of the bureau and is brought about by the chemical reduction of a nickel or cobalt salt with hypophosphite in hot solution. The reaction is catalytic, and under the prescribed conditions of concentration and pH no plating occurs unless certain metals such as steel or nickel are introduced in the bath. Once started, the reaction continues at the surface of the immersed metal and only rarely in other parts of the bath. For this reason the container should be of glass, plastic, or other noncatalytic material. The resultant coating is said to be of 93 to 97 percent purity.

Objects to be plated are cleaned by any of the accepted procedures and are given an acid dip before they are suspended in the hot solution. Generators, rheostats, special racks, or contacts are eliminated by the use of the electroless method, and small parts that cannot be barrel-plated economically are readily coated by means of it if held by a string or in a bag affording ample exposure of the metal surfaces to the solution. The latter does not have to be kept continually in motion, because current distribution is not involved.

The composition of the bath may vary within wide limits, and while nickel can be deposited from either acid or alkaline solutions, cobalt and cobalt-nickel alloys have been obtained only from ammoniacal solutions. In addition to the metal ions and hypophosphite, the alkaline solutions contain hydroxycarboxylic salts and ammonium salts to prevent precipitation of the metal salts, as well as certain alkalies to regulate the pH. In acid nickel solutions, organic acids serve as buffers.

The rate of deposition is about the same as in barrel electroplating—from 0.0002 to 0.0008 inch per hour, depending upon the kind of solution used. During the process, the pH must be kept within a certain range; and if the operation is of long duration, the nickel salt and hypophospite have to be replenished at regular intervals. The yield or efficiency of the reduction based on the decomposition of hypophospite is 37 and 66 percent for nickel and cobalt, respectively, about 2 grams of nickel or nearly 4 grams of cobalt being reduced by 10 grams of sodium hypophosphite. Because of the moderate yield and the present high cost of the chemical the method is expensive, and its extensive commercial application will probably be contingent upon a cut in price.

As formed, the nickel deposits are brittle but become ductile when heated. They are harder than the ordinary types and become still harder upon heating. This is in contrast to the behavior of "hard" electrodeposited nickel, which has high initial hardness but softens upon heating. Adhesion of electroless nickel to mild steel is such that it cannot be flaked off by bending, but in the case of high-carbon steel this property is less pronounced. In comparative salt-spray tests of steel plated with 0.0002, 0.0005, and 0.001 inch of nickel, the protective value of electroless and electrodeposited coatings was virtually the same. Electroless cobalt, however, does not compare so well in this respect with electrodeposited cobalt.

Noncatalytic metal surfaces may also be plated by the new process in two ways. If a film of palladium or rhodium of nearly monatomic thickness is first applied to such a metal by chemical replacement, deposition of nickel or cobalt on the activated surface will start and continue because of the catalytic action of the initial deposit. Copper may be coated in this way. The second method of initiating the reduction is to bring a less noble metal such as iron or aluminum in contact with the noncatalytic metal while it is immersed in the hot solution.

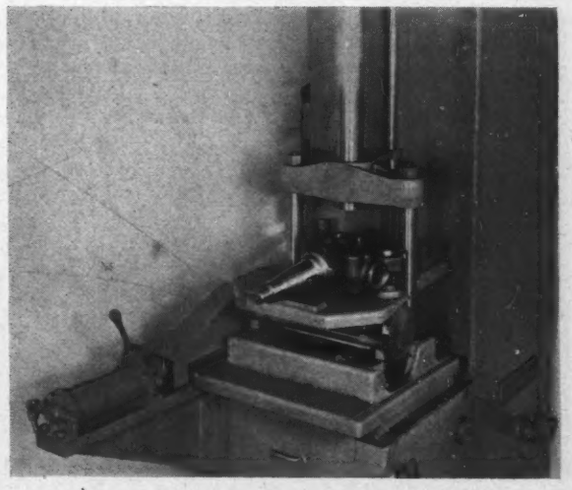
Photomicrographs of deposits obtained by the electroless process show laminations and a columnar structure similar to those of bright nickel electrodeposits. The former are of good quality, sound though brittle, and unusually bright. Because they can be made as hard as tool steel, the new method may prove useful where hard, wear-resistant surfaces are required, as in bearings. The process is particularly applicable to the plating of recesses, irregular-shaped objects, and inclosed areas such as tubes, where a centered internal electrode with special current leads would have to be used in the case of electroplating.

Pneumatic Fixture Simplifies Broaching

BROACHING keyway slots in heavy-duty steering knuckles has been greatly facilitated, it is claimed, by an air-operated eccentric fixture developed by the Colonial Broach Company for service in connection with its 10-ton Utility hydraulic press. The latter is equipped for the purpose with a standard pull-down broaching attachment which insures accuracy of alignment through guide bars sliding in bushings pressed into the platen bed. The lower tie bar of the attachment carries an adapter that permits the use of varying automatic pullers.

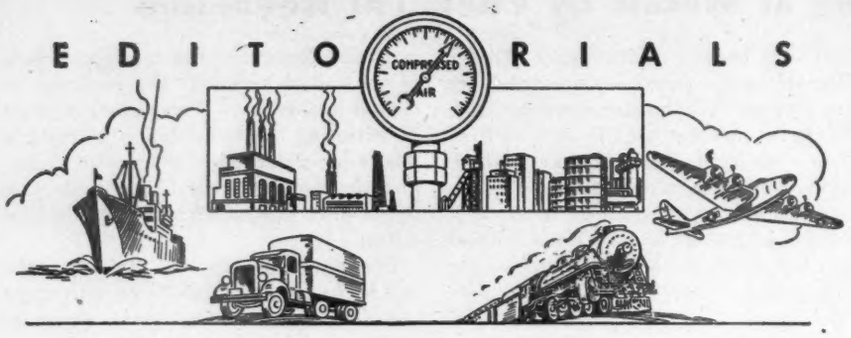
The fixture consists essentially of a bed plate, of an indexing arrangement, and of an air cylinder with a 7⅞-inch stroke. With the broach in the "down" position, as shown in the accompanying picture, a knuckle is placed on the fixture and a short handle that controls the pneumatic cylinder is pulled back, retracting the cylinder piston and thereby lifting the plate on which the work rests. At the same time, an eccentric cam at the right of the fixture moves the plate slightly toward the operator. The pull-down attachment is then raised to its full height by the upstroke of the press ram, thus bringing the broach up through the bore ready for slotting. But first the handle is pushed forward to admit compressed air to the cylinder and to lower the fixture. The latter is then in position for cutting the keyway slot by pulling the broach down through the bore.

Of the two bores in each knuckle, only one is dealt with at a time. After the completion of a run, the fixture is indexed and the other bore is slotted. The advantages claimed for the pneumatic attachment are ease of loading and increased production.



IN STARTING POSITION

Fixture is shown here with a steering knuckle on the raised bedplate and with the pull-down attachment and broach in the "down" position. The latter passes through the bore during the upstroke of the press and is brought into slotting position by pushing the cylinder-control handle forward and thus lowering the fixture. The broach is then pulled down to cut the keyway slot. Pressure required to operate the pneumatic attachment ranges from 60 to 75 psi.



A JOB FOR ADVERTISERS

DON'T be surprised if advertisers in this and other trade publications begin devoting some of their space to a defense of our politico-economic system—the so-called American way of life. Not only concerns that manufacture machinery and other goods but also those, such as banks, that purvey services are keenly aware of the fact that their future prosperity is contingent upon the survival of the free-enterprise system. It seems almost ridiculous, as was pointed out on this page last month, that it should be necessary to defend a way of doing things that has put this nation on the highest plane of living ever attained anywhere. The late Al Smith assured us that nobody ever shoots Santa Claus, but there is ample evidence that plenty of guns are cocked and aimed at him in this instance.

Warnings that subversive influences are at work are being sounded with increasing frequency by leaders in various fields of endeavor. All emphasize that a large percentage of the general public is unaware of the real situation and that another sizable segment has been lulled into believing that our drift towards national socialism is actually a desirable trend. These people apparently think that the national treasury is bottomless and that it can endlessly provide security for everybody. They have never bothered to figure out from where the money will come if the profit motive is taken out of manufacturing and selling.

It may be argued that "big business" has the most at stake in preserving the *status quo*, but even the largest corporation is but an aggregation of individuals. Some of them are employees, others are stock or bond holders. All are necessary to the success of the undertaking, and all will suffer if state ownership supplants private ownership.

Management is fast awakening to the gravity of the situation and accepting its responsibility to those who gain a livelihood from the operations it directs. The obvious need is a selling campaign to reëstablish the principles of Americanism in the public mind. Of immediate concern is the necessity of arousing whole-hearted support for the "feed Europe" campaign. Starving people are receptive to radical ideas, and once the cancerous growth of communistic ideology grips Europe, it will be exceedingly difficult to stop it from spreading to America. That is why those who direct the nation's advertising programs are thinking seriously of using some of their appropriations to sell Americanism to Americans. If that is not done now there will be precious little incentive to sell material goods in the years to come.

●

TRY A NEW APPROACH

APPLICATION of the spirit and, to some extent, the methods that have enabled scientists to unlock the doors leading to countless valuable inventions and processes has been urged by some of our leading thinkers as the most likely way of eventually solving the problem of creating a workable world social order. The problem grows bigger all the while, and it is apparent that some new approach to it must be found. Even when it was relatively simpler, nations could not live together amicably. Now we live in a very involved world, a tired one with jumpy nerves, and much of it with empty stomachs. It will be a tremendous job to bring order and common understanding out of all this chaos, and it can't be done by methods that have traditionally failed to work.

The early important scientific discoveries were largely the result of individual efforts. Watt's steam engine, Westinghouse's air brake, and Bell's telephone are outstanding examples. As society grew more complex, organized research took over and has now reached the point where single firms spend millions of dollars a year on it. Scientific progress has become a partnership affair and is functioning with undeniable effectiveness.

It has been said that all things are in nature, but many of them are hidden and can be rooted out only by persistent digging. Immanuel Kant described the work of the scientist as compelling nature to reply to his questions. Each new secret uncovered teaches us more about natural processes, and we can frequently copy them and so duplicate some of nature's creations. Man learned to make paper from wood pulp by studying wasps' nests. A more recent example is the synthesis of "artificial silk", now called rayon.

Modern scientific research has pushed international borders back or aside. The telephone, radio, motion picture, airplane, and other products have so compacted the world that no nation may longer think in terms of itself alone. It is not surprising that differences arise among the heterogeneous peoples that have suddenly become more or less a one-world family. The resolution of their divergent viewpoints will not come about in a day or a decade, but it must ultimately be achieved, or the jig is up for all of them. Unless some way is found for nations to live together peaceably, civilization will be disintegrated by another fruit of the scientific tree—the atomic bomb.

The specter of that awesome missile will probably loom in future years as a gargantuan international policeman holding up a hand to maintain order. As yet, however, not all governments have chosen to acknowledge this realism. They continue to play at bluff and bluster, although those tactics have now lost their potency. Perhaps this is merely a false front to screw up courage, analagous to whistling when passing a cemetery in the dark of the moon. It is to be hoped that they will take off their masks soon and face the fundamental fact that any country that attacks another in this age is flirting with annihilation.

A peace that has to be maintained by the threat of force is not desirable. It is merely a truce that will last until one nation or group of nations thinks itself strong enough to start throwing rocks at its neighbors. The elimination of world animosities can come only within mens' minds. Nations must abandon artifice and subterfuge and work together to establish a common ground of understanding if we are to have enduring peace.

Our efforts to solve world problems are no farther advanced today than was scientific research in the days of Watt, Westinghouse, and Bell. Individuals of many nations, capable and sincere men, have done their utmost to further world peace, only to find their motives questioned and their efforts blocked. Even their own countrymen have sometimes failed to give them deserved backing. The job is a far bigger one than scientists have ever faced, but perhaps the trend of technological investigation in recent years has produced a formula that may be well worth trying. Maybe it is true that the answer to all things is to be found in nature if enough people band together and start probing in the spirit of the scientists. Such a scheme cannot succeed, however, until all the leading world powers agree that they want peace—and want it on a permanent rather than a transient basis.

This and That

Progress in Shaft Sinking

In June a vertical shaft of elliptical cross section and fully lined with concrete was sunk 302 feet at the Van Dyk Mines in South Africa. Partly responsible for this fast progress was a new device for placing concrete. Termed "octopus," it consists of a cylindrical steel hopper in which concrete, lowered from the surface, is deposited. Around the bottom of the hopper are welded ten pipes or nozzles, to each of which is attached a 6-inch rubber hose. Through these lines the material can be distributed to all parts of the lining area. In practice, only one or two are used at a time, the others being blocked off by inserting wooden plugs in the pipes. At Van Dyk, the octopus was hoisted to the surface when not in use, but in sinking a new shaft at the St. Helena Mine it is planned to incorporate it in the galloway stage that remains in a shaft during sinking operations. This will increase the weight of the stage to around 11 tons and add to the difficulties of handling it, but inclusion of the octopus is, nonetheless, considered worth while in view of its contribution to greater speed and better distribution of the concrete. The June progress at Van Dyk is believed to be the best ever made on a shaft of that kind. The record for all types is a mark of 441 feet set in April, 1940, at West Rand Consolidated Mines. This was a 6-compartment shaft of rectangular section measuring 37¼x13½ feet and was lined with timber instead of concrete. The Van Dyk shaft has five compartments and is 35x15 feet across its axes.

* * *

Air Tools Fight Big Pier Fire

New York City fire fighters, called to a blaze at Pier 57 on the Hudson River on the night of September 28, found that the flames were underneath the 5-inch concrete floor, among the creosoted piling and other supporting members. In order to get water on them, they began drilling holes through the concrete with Jackhamers for the insertion of 3-headed revolving nozzles. Two portable air compressors owned by the fire department were supplemented by a number borrowed from other city divisions and public-utility companies, and eventually twelve units were at work with their complements of drills and paving breakers. Even with this array of equipment it was not possible to cope with the flames, and on the following day the 800-foot-long structure began to collapse. A 100-foot section at the offshore end was the first to go down, and with it four of the compressors dropped into 40 feet of water. During the next few hours three more sections, representing most of what remained of the pier, crumbled. Estimating the damage at $5,000,000, fire-department officials said the fire was the costliest pier blaze in the city's history. It brought out 80 pieces of land apparatus and six fireboats, and hundreds of firemen, working 400 at a time in 16-hour shifts, fought the flames three days and nights. First aid was given to 153 who were injured or affected by smoke. The pier was built by the city in 1905 at a cost of $1,200,000 and had been leased to the Grace Steamship Company since 1936.

* * *

Hoisting Methods of Incas

The discovery among Inca ruins of high buildings containing huge blocks of stone has aroused speculation as to how those heavy objects were elevated and put in place. A writer in the *New York Herald Tribune* states that there is really no mystery about it, and offers the following explanation: The large stones were quarried high in the mountains, being broken loose from the mother rock by the natural freezing of water poured in grooves. Blocks thus extracted were moved to the building site on rollers and similarly hauled up to their positions on ramps of earth. As the structure rose, the ramps were increased in height. After the building was completed, the earth was removed from around it. This technique could, of course, be followed only where thousands of slaves were available to do the pulling.

* * *

English Triple Tunnel

Dual subaqueous tunnels, with a tube to accommodate traffic in each direction, are fairly common in this country, but the English are going us one tube better. To relieve one of the worst bottlenecks in the British Isles, work was started last summer on triple tubes under the Tyne River in the Tyneside area, which embraces six towns having an aggregate population of 1,450,000. For the present, two small tubes for the use of pedestrians and cyclists will be built. Later a larger vehicular tunnel will be added. Approximately $15,000,000 will be spent on the undertaking. A concentration of coal fields, shipyards, and industries in the section concerned makes for heavy cross-river traffic, which is now handled by one bridge and numerous ferries.

PHOTO, COURTESY, CONSTRUCTION METHODS

SHUCKING THE SHEKELS

The Security-First National Bank of Los Angeles, Calif., uses an ordinary concrete mixer to remove packaged coins from their wrappers. Chief Teller Bill Ream had the idea, and it works well. The blades of the mixer quickly break the paper coverings, and the pieces of paper are blown away by a jet of compressed air. The loose coins are discharged through a hopper into a canvas sack. The picture shows a bank employee shoveling mazuma aggregate into the mixer, which occupies a place in the vault.

Finishing Metal Surfaces by New Process

VAPOR-BLAST CABINET

The Model B-20 Jr., which is equipped with a standard 3x4-foot hopper, abrasive pump, self-contained exhaust, and filter with interval backwasher. A window gives full view of the blasting chamber, and arm-long gloves attached to ports in the cabinet protect the operator when the work is done manually. Units can be converted into completely automatic conveyor types with turntables, tumbling baskets, or such other equipment as may be required by the user. Simply by varying the size of the spray nozzle, the air pressure, and the chemical emulsion-abrasive mixture, a cabinet can, it is said, produce innumerable finish combinations. Cabinets suitable for production lines have been designed.

METAL surfaces are being finished by a process of liquid honing by which they are exposed to the attack of a mixture of fine abrasive and chemical emulsion applied by compressed air. It was developed by the Vapor Blast Manufacturing Company as the result of a change in its method of sandblasting, whereby water was added to the stream of air and sand to eliminate dust. Wet sandblasting, first used to clean buildings and to remove concrete latence from new structures, was adopted later by structural-steel manufacturers and foundries for the removal of scale and rust from large castings, etc. Experimentation with rust-inhibiting chemicals and finer abrasives led to the newer application and equipment for cleaning, deburring, polishing, or otherwise finishing products ranging all the way from delicate watch parts to large crankshafts and steam-turbine rotors.

Novaculite, a form of siliceous rock varying in fineness from 100 to 5000 mesh, is the principal abrasive employed for liquid honing. Silica sand and ground quartz also are utilized, as well as commercial abrasives such as boron carbide, garnet, and aluminum oxide. Walnut shells, corncobs, peach pits, corn meal, and other organic materials reduced to 40 mesh are suitable for special applications. Some polishing jobs are done in stages by blasting with successively finer abrasives, the kind and size depending upon the work being done. Each is "prescribed" for a given operation for use singly or in combination with others, and is supplied in moistureproof cartons containing 50 pounds, or sufficient for one charge of a blasting cabinet.

Liquid honing, according to the company, gives a smooth surface with a nondirectional finish that has the appearance of being finely etched. The peening action of the abrasive particles, which are delivered at a maximum velocity of 3200 feet per second, results in minute pits which, in the case of sleeve bearings, for example, hold and evenly distribute lubricants. Peening likewise has the effect of cold-working the surface of the metal, thereby improving its tensile strength anywhere from 5 to 10 percent.

Deburring, often a tedious task by ordinary methods, is said to be quickly and easily accomplished by liquid honing because the fine abrasive reaches internal filets, edges, and corners that are sometimes difficult if not impossible to get at by other means. Pump parts such as impeller vanes, carburetor housings, flexible-type couplings, and instrument parts are among the many products that are being deburred in this way.

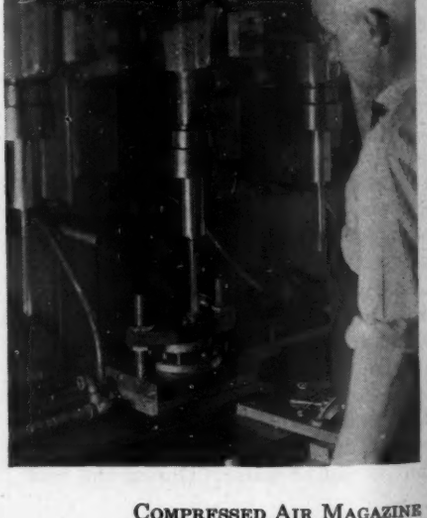
Another advantage claimed for the process is maximum cleaning and polishing with minimum metal removal and dimensional change. This is of importance in the manufacture of molds and dies, as well as to the die-casting and rubber-, glass-, and plastic-molding industries. Dies and molds have to be cleaned periodically. Users report that the productive period between cleanings is several times as long with liquid honing as it is when the work is done by conventional practices. Periodic liquid honing also serves to keep sharp cutting edges on machine drills, taps, hobs, and similar tools; and the method has been used to refinish metal propellers of airplanes and to finish the interiors of jet engines.

New Air Aid for the Machine Shop

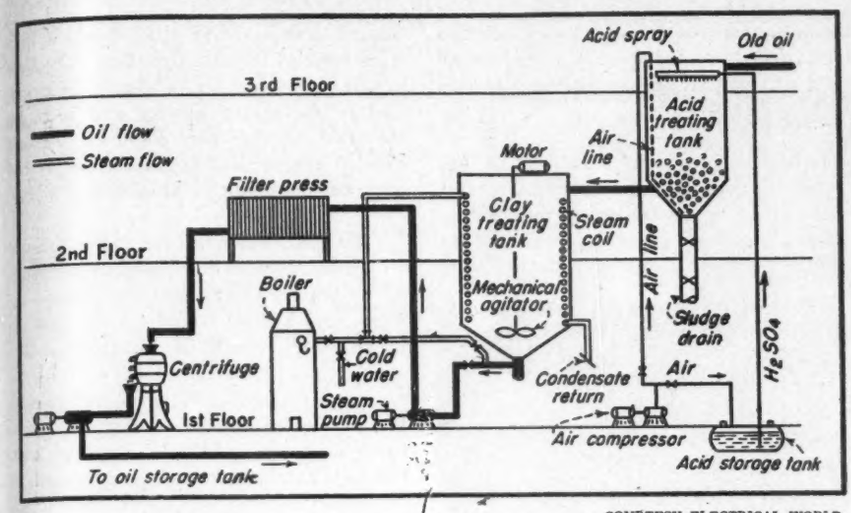
A PNEUMATIC work-holding fixture, called the Air-Grip Jig Base, has been designed by Industrial Clutch Corporation to provide a faster method for the production drilling of parts with a jig. The use of air pressure, controlled either by a hand- or foot-operated air valve, has been found to save time in drilling a quantity of identical parts and to make the work easier than with hand-clamping devices.

Every jig base is provided with an air valve and cylinder and can be used with several sizes of jigs having bushings spaced so that they will go over the posts of the base. To start a production-drilling job, a base of the proper size to hold the work and top plate is selected. It is placed on the drill-press table and connected to the air line, with which each machine tool in the plant is equipped. The work is laid on the Air-Grip Jig Base and the jig is slid down over the posts to rest on nuts which hold it off the work when the air is off. With the part properly located with reference to the jig, the upper and lower nuts are tightened on each post to hold the jig firmly.

When the operator is ready to drill, he turns on the air. The pneumatic cylinder in the base pulls down the posts and attached top plate, clamping the work securely. When drilling is completed, the operator shuts off the air, and springs cause the jig plate to rise and release the work. Repetitive operations on similar parts require nothing more than sliding each one into position on the base and under the jig plate, turning on the air, drilling, turning off the air, and pulling out the work. The introduction into and removal from the fixture of each piece once the fixture has been set up can be done fast and with little effort. Use of the foot-operated air control leaves both hands free for quick adjustment or withdrawal of work when large pieces are being handled.



Low-Cost Reconditioning of Transformer Oil



COURTESY ELECTRICAL WORLD

TRANSFORMER oil is being reconditioned at a cost of seven cents a gallon by a plant that combines acid treatment, clay treatment, filtering, and centrifuging. Designed for maximum speed of operation with minimum attendance, the equipment is said to treat approximately 600 gallons daily with an over-all loss of 6 to 8 percent.

Oil to be reclaimed is pumped from storage vats to an acid-treating tank, where 0.05 gallon of sulphuric acid is added by an air spray for every gallon admitted. Compressed air is also used to agitate the acid-oil mixture for about one hour. It is then allowed to stand for a period of sixteen hours so that sludge will settle to the bottom, where it can be drained off.

The sludge-free oil flows into another tank where 0.75 pound of No. 1 Mill-white clay is added per gallon. The mixture is now stirred mechanically and heated by a steam coil until it reaches a temperature of 275°F., when live steam is introduced to agitate it. This stage of the process requires about one hour, during which time the temperature is held constant at 275° and vapors are exhausted by a blower.

Following the steam treatment, the clay-laden oil is cooled to 140° by circulating cold water through the steam coil. Final steps in the reconditioning process consist in passing the mixture through a filter press to remove the clay and through a centrifuge to extract any remaining moisture before the oil is delivered to a storage tank for reuse.

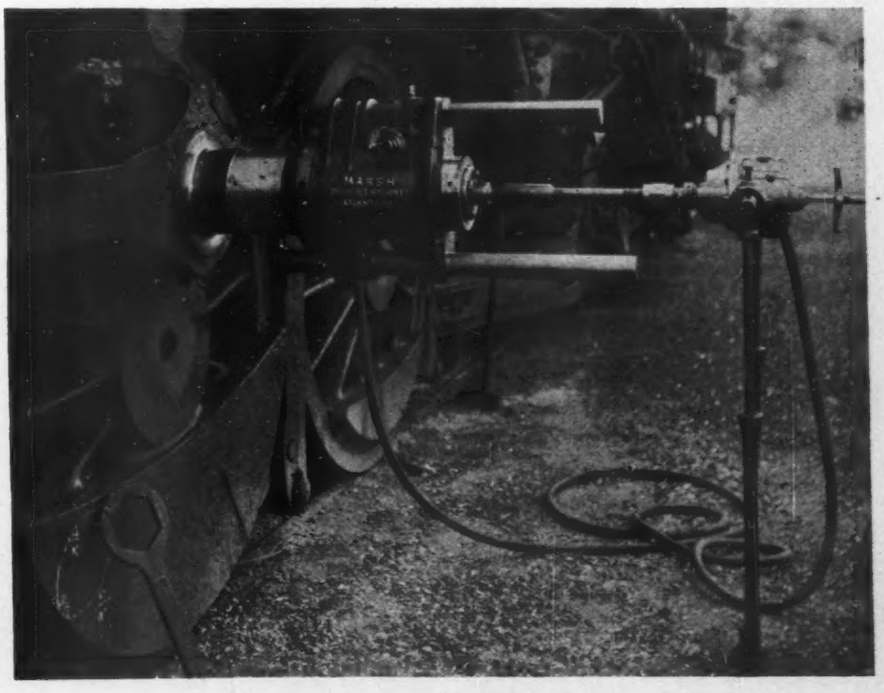
Portable Machine for Locomotive Crankpin Maintenance

A HEAVY-DUTY, portable machine that quickly turns and polishes all sizes of locomotive crankpins, as well as journals on powerhouse machinery, has recently been placed on the market by the Mechanical Equipment Company, Atlanta, Ga. It was designed by C. E. Marsh, a member of the maintenance staff of the Seaboard Air Line Railroad.

Equipped with detachable cutting or grinding heads, the machine is powered by either an air or electric motor. It revolves on a spindle connected to the end of the crankpin by an adapter, and is supported at its free end by the motor stand. The various types of adapters used are fastened to the crankpins by means of bolts, studs, or sleeve nuts and can be furnished for any type of locomotive crankpin or journal. Attachment of the spindle and proper alignment of the machine require only a few minutes and are done without the aid of measuring tools.

The sliding tool bar is made of chrome-nickel steel and has a gear-driven reversible feed with fine and coarse feeds in both directions. The high-speed-steel cutter head may be set at any desired angle and has a turning range of from 4 to 12 inches in diameter and a travel of 20 inches without changing the tool bar. Both the tool-bar and spindle bearings are adjustable for wear. Reversible feed stops are provided for the grinding head, which has a built-in 2-hp. air motor to turn the wheel and which feeds out with the tool-bar travel and revolves with the machine. Air is delivered to the motor by a telescope pipe line extending to a collector or the end of the machine.

The total weight of the unit with accessories is 450 pounds. When not in service it is stored in a steel box that is mounted on truck tires for mobility and that has a swivel hoist on one end to facilitate placing the machine in operating position.



IN OPERATION

The machine is shown turning two journals of a locomotive crankpin at the same time. The driving element at the right, supported by a stand, is a reversible air drill.

Industrial Notes

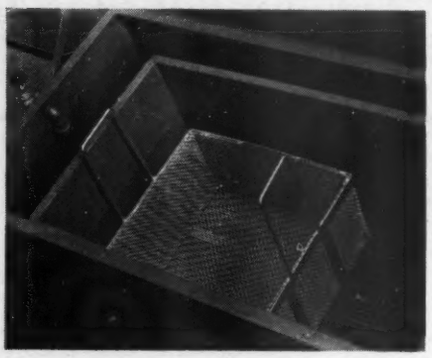
Automobile headlights can be converted into foglights in no time at all, says the Hazelite Company, by covering them with amber-colored lenses. Made of plastic, they fit any sealed-beam headlight and are held firmly in place by K Monel clips. They are being sold under the name Hazelites.

In collaboration with one of the country's leading automobile manufacturers, The B.F. Goodrich Company has produced an adhesive that is to be used by the former in place of brass rivets to anchor brake linings. Called Plastilock 601, the material is entirely synthetic and is said to have more than twice the rivets' shear resistance. So attached, the lining, according to Goodrich, does not need to be replaced until it is worn right down to the shoe, and with the absence of rivets there is no possibility of cutting ridges in the drums. Although developed specifically for the purpose mentioned, the adhesive has manifold applications and is to be made available in tape and liquid form. It requires a severe curing period under heat and pressure.

A new Forrester Alloy Sprayer for low-temperature metals has been announced by K. & F. Metal Spray Industries. The unit uses alternating or direct current and has a built-in heater of ni-chrome wire embedded in a refractory material encased in high-temperature chrome steel. Alloy is dropped into the melting pot and is said to be ready for spraying with compressed air at from 30 to 40 psi. in from two to ten minutes. Air is admitted by pressing a button on the handle of the "gun," and temperature can be maintained at any point from 100 to 600°F. within 1/10 degree. Three models of a horizontal or

a vertical type are available with pot capacities of 6, 12, and 24 cubic inches, respectively. It is claimed that the units can deposit metal to a thickness of ¼ inch on an area 24 inches square in 60 seconds. Uses of the equipment are too long to list here, for there is no end to the kind of surfaces and products that can be spray-coated.

Fast and thorough removal of oil, grease, chips, and other foreign matter that collect on parts during machining, drilling, boring, grinding, and similar production operations are claimed for a



new automatic multiflow, double-compartment, cold-type tank cleaner manufactured by Turco Products, Inc. Named Turco Turbulator Tank, it depends for its effectiveness on compressed air, pressure differential, and gravity and does its work with a combined liquid-scrubbing and solvent action. Air at a working pressure of approximately ½ pound is released through tiny orifices in the outer chamber, inducing an up and down movement of the cutting solution and forcing it through and around the parts in the inner one. Particles of dirt are washed up and over its side walls into the outer compartment, where a baffle plate deflects and permanently traps them in a sludge chamber underneath so that only clean fluid is circulated. Small parts are placed in a wide-mesh wire basket which permits the liquid to flow freely and to penetrate generally inaccessible ports and channels. There are four models with capacities of 52 to 765 gallons and suitable for cleaning anything from a typewriter to a large diesel motor block.

In connection with its gas-turbine research work, the Westinghouse Electric Corporation has developed a fuel nozzle that is said to be a far better atomizer than the conventional mechanical nozzle. The new device has six tiny ducts that are set at an angle to the axis of the nozzle and through which low-pressure air is fed at the rate of less than 1 cfm. The compressed air collides with the incoming oil, breaking it up into a spray made up of particles that are about ten times smaller than those produced by the older nozzle, both using No. 6 oil and operating under a pressure of 5 psi. In other words, where one delivers the fuel in dribbles, the other feeds it in a solid cone of fog-size droplets. The new nozzle is designed for locomotive, marine, and public-utility service and is to be installed in the new 2000-hp. experimental gas turbine-generator set at the corporation's South Philadelphia Works.

Designed especially for industrial use where segregated buildings are connected by water, steam, and compressed-air lines, the Globe Geophone is said to make quick work of locating underground leaks. Unit operates on the seismograph principle. When placed in contact with the ground, it detects vibrations emanating from a distance and, through rarefaction and compression of air sealed in the instrument, transforms them into sound waves that are carried to earphones by rubber tubes. The geophone is made by the Globe Phone Manufacturing Corporation, which claims that it seldom takes more than fifteen or twenty minutes to trace a water leak anywhere within a radius of 50 or 75 feet.

Inventory time, always a nuisance, is more so if it involves moving heavy stock to platform scales and back again. To lighten as well as to expedite the work, W. C. Dillon & Company, Inc., has developed a portable dynamometer scale that is suspended from a crane or hoist hook and registers the weight in pounds

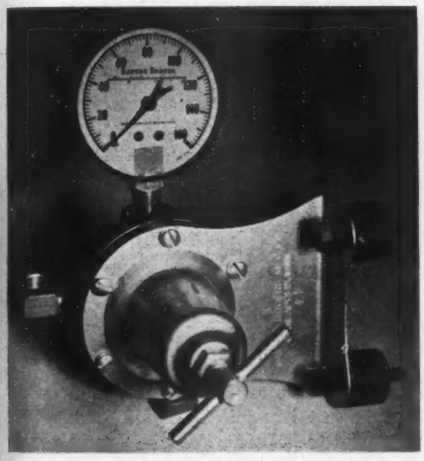
on the face of a dial. It picks up its load right at the stock pile and replaces it without lost motion. There are a number of models all of the same size but ranging in capacity from 0-500 to 20,000 pounds.

Ray-Man is the trade name of a new lightweight air hose that has been designed by Raybestos-Manhattan, Inc., for service where ordinary hose is too heavy and cumbersome. It is intended

primarily for benchwork with small pneumatic tools and wherever air is required for blowing out or cleaning confined areas. Of the company's Homo-Flex construction with rayon as strength members, it is said to be easy to handle, flexible, and strong. The hose is also available in an oilproof type. Both are made in sizes from ¼ to ½ inch.

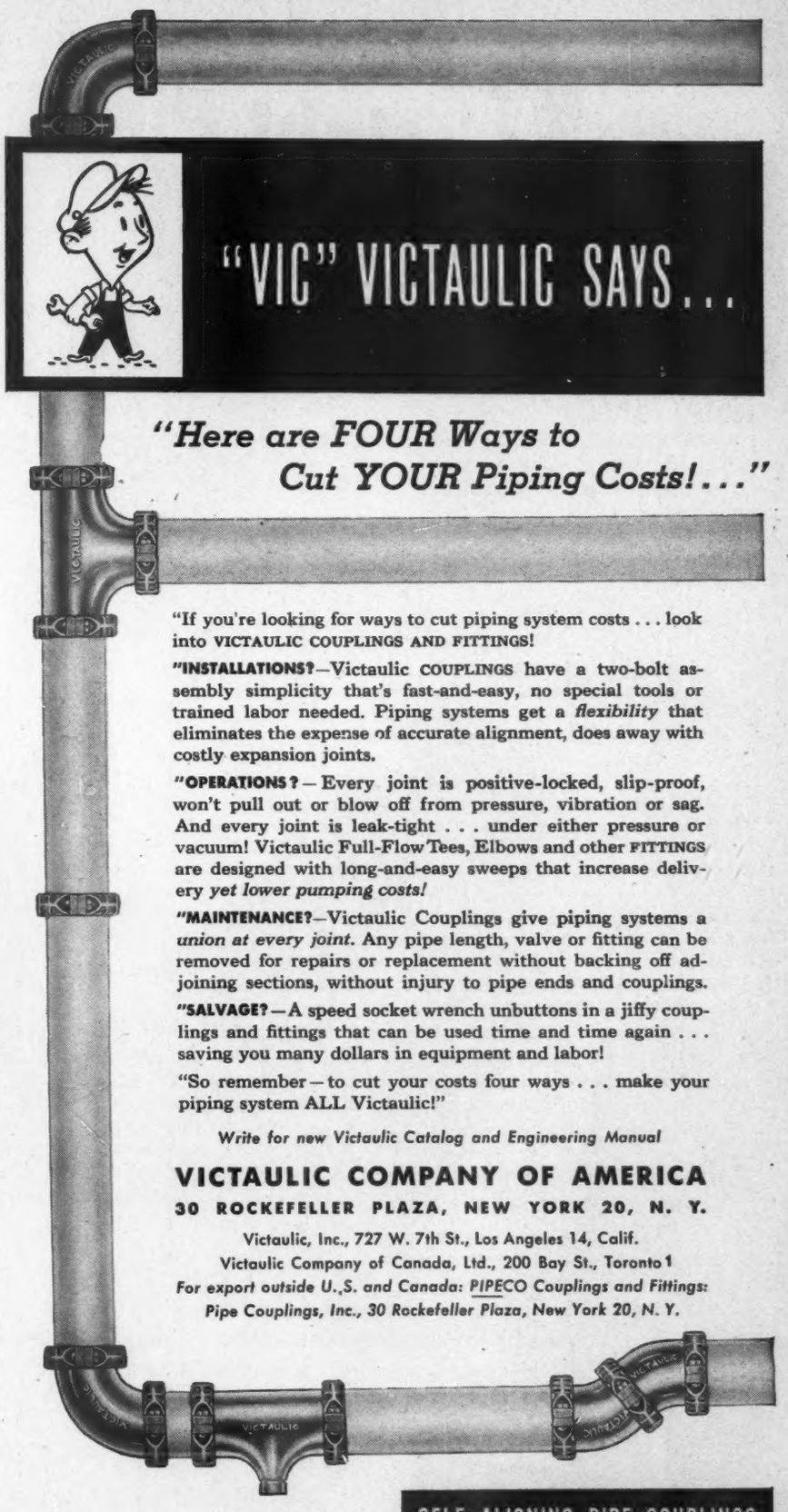
Goodyear Tire & Rubber Company has developed a new hose for heavy-duty steam or hydraulic service. The material that gives it maximum heat resistance is spun-glass yarn, which is used together with rubber. The result is a line that is said to carry saturated steam at 200 psi. and 388°F. for more than 300 hours under continuous flexing—conditions that would char and burst ordinary hose.

For shop air lines, Dayton Rogers Manufacturing Company has developed a new combination reducing regulating valve and pressure gauge that is designed to meet the needs of tools and equipment using air within the range of 5 to 150 psi. The valve permits lowering the primary pressure to the desired secondary or working pressure and maintains it at that point, while the gauge



gives a continual record of the pressure at which the tools on the line are being operated. The unit is available in four sizes for ¼-, ⅜-, ½-, and ¾-inch pipe connections, and each is protected against vibration by two rubber shock absorbers.

Knox Industries, Inc., is manufacturing a 4-way air valve that goes by the name of Air-Miser because it is said to effect a 50 percent saving in air consumption. The feature that makes this possible is a port in a bronze disk by which half of the compressed air required for the power stroke of a double-acting cylinder is by-passed through an accumulator to the opposite end of the cylinder to return the piston to the starting position. This air is usually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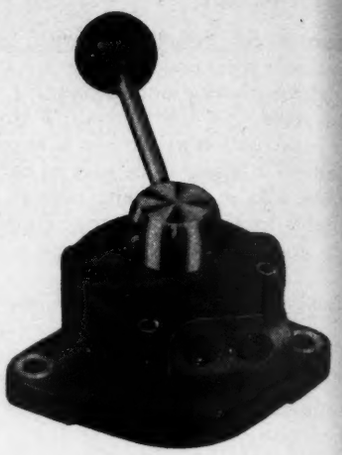

exhausted by valves of the conventional type. The Air-Miser has an auxiliary port that admits air should more than that stored in the accumulator be needed for the return stroke. It also has a neutral position which serves when the cylinder is idle.

Monel- or nickel-clad steel strip that can be stamped, drawn, spun, bent, spot-welded, or otherwise fabricated as readily as ordinary low-carbon deep-drawing steel is being made by the Superior Steel Company. With a standard coating of 10 percent of the total thickness on one or both sides, the material is available in widths from ¼ inch to 10¼ inches and in coils containing up to several hundred feet, depending upon the gauge. Thicknesses vary from 10 to 125 thousandths of an inch for cold-rolled strip and from 95 thousandths of an inch to ¼ inch for the hot-rolled type. Separation of the cladding from the base can be effected only by chemical dissolution, it is claimed. Material costs from 30 to 35 percent less than solid strip and is intended to supplement it, not to serve as a substitute for it.

Dependence of the paint industry on natural oils and resins may be considerably reduced if a substitute vehicle announced jointly by the chemical consulting firm of Foster D. Snell, Inc., and Shawinigan Products Corporation, resin manufacturer, is all that is claimed for it. The new vehicle is a dispersion of a totally synthetic poly-vinyl resin in water and, when used instead of the customary oils, produces a coating that is said to dry in less than half an hour without odor and to possess the durability and finish of high-class oil paints. The new product bears the trade name Gelva paint and is made in a full range of colors from black through the usual deep shades and pastel tints to pure white. It can be applied by brush or air spray, can be washed or scrubbed, and its lack of volatile and flammable solvents minimizes both fire hazard and toxic effects. Paints are to be produced and marketed by paint manufacturers.

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